

## Original Research Article

# Correlation between mean thrombocyte volume and microalbuminuria in type 2 diabetes mellitus patients

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## ABSTRACT

**Background:** The determination of microalbuminuria is beneficial in detecting cases of type 2 diabetes mellitus (T2DM), which can result in renal and cardiovascular diseases. A few studies correlating mean thrombocyte volume (MTV) with microalbuminuria have shown positive results; however, data remain limited in the Indian population. The present study evaluated the association between MTV and microalbuminuria in patients with (T2DM).

**Methods:** This hospital-based cross-sectional study was conducted from February 2023 to January 2024 in Maharashtra, India. Sixty patients of either sex, aged 18 years or older, with a duration of T2DM greater than four years and diagnosed according to American Diabetes Association criteria, were included. The duration of diabetes mellitus (DM), HbA1c, and urine microalbumin were noted. The primary objective was to determine the relationship between MTV and microalbuminuria, while the secondary objectives were to assess the associations between MTV and the duration of T2DM and between MTV and HbA1c. The sample size was statistically powered to detect a significant correlation between MTV and microalbuminuria, aligning with findings from prior research.

**Results:** The mean MTV was significantly elevated in patients with a duration of diabetes greater than ten years, HbA1c >7%, and urine microalbumin levels >30 mg/g. A significant positive correlation of 0.936, 0.552, 0.875 and 0.433 was observed between MTV and urine microalbumin levels, the duration of DM, HbA1c and age, respectively.

**Conclusions:** MTV serves as a simple and cost-effective marker for assessing glycemic control and early detection of renal involvement in T2DM. The study reinforces the potential role of MTV as a supportive tool for monitoring disease progression and guiding preventive care in diabetic patients.

**Keywords:** Correlation, Diabetes mellitus, HbA1c, Mean thrombocyte volume, Microalbuminuria

## INTRODUCTION

Diabetes mellitus (DM) is an inherited metabolic condition marked by persistently high blood glucose levels resulting from either a partial or complete lack of insulin. Worldwide, approximately 537 million individuals are affected by diabetes, including about 90 million in Southeast Asia. Projections from the International Diabetes Federation and the Diabetic Association of India suggest that this figure will increase to 151.5 million in Southeast Asia by 2045. Furthermore, it is anticipated that by 2030, 366 million people will be living with diabetes, of whom nearly 290 million will be in developing nations.<sup>1</sup>

The management of macro- and microvascular complications is the primary cause of expenses due to DM.<sup>2,3</sup> Long-lasting high BSL leads to failure of the circulatory, excretory, nervous system and vision.<sup>4</sup> Type 2 diabetes mellitus (T2DM) causes increased thrombocyte activation and coagulation of proteins and diminished fibrinolytic activity.<sup>5</sup> This change in thrombocyte activity leads to retinopathy, nephropathy and neuropathy.<sup>6</sup>

When mean thrombocyte volume (MTV) increases, the probability of thrombosis increases because abnormally large thrombocytes are extra responsive and at risk of forming clots, indicating a higher hemostatic potential.<sup>7</sup>

Augmented thrombocyte size appears to be linked with T2DM.<sup>8</sup> The positive correlation of MTV with cardiovascular disease (CVD) and death is reported.<sup>9,10</sup> The MTV is an easy and inexpensive test to measure thrombocyte size by routine automated hemograms at a low price. Microalbuminuria is the earliest predictor of diabetic kidney disease progression, affecting 20–40% of patients with T2DM.

Similarly, it robustly prognosticates the possibility of CVD, independent of traditional and non-traditional risk factors.<sup>11,12</sup> Microalbuminuria also appears to be an indicator of microangiopathy in DM.<sup>13</sup> Detecting microalbuminuria is useful for identifying patients with T2DM who are at risk of developing kidney and cardiovascular diseases. The albumin-to-creatinine ratio in a spot urine sample is sufficient for diagnosing microalbuminuria and evaluating the effectiveness of treatment aimed at reducing it.

The urinary albumin >30 mg/g of creatinine is evidence of microalbuminuria and is a conventional risk factor for kidney disease progression in T2DM and is the initial clinical sign of diabetic nephropathy. It was reported that the average MTV was markedly elevated in the poorly controlled DM group and MTV was significantly positively correlated with albuminuria.<sup>14</sup> It was observed that an elevated MTV was associated with uncontrolled blood sugar, long periods of DM, and an augmented occurrence of vascular complications, and MTV could be used as an inexpensive indicator to prognosticate vascular complications in patients with T2DM.<sup>15</sup> A few studies correlating MTV with microalbuminuria have shown positive results; however, such studies are limited in the Indian population. Hence, the present cross-sectional observational research was conducted to find the relationship between MTV and microalbuminuria in T2DM patients.

**METHODS**

This hospital-based observational correlation study was conducted from February 2023 to January 2024 in Poona Hospital and Research Centre, a tertiary-care referral hospital in Pune, India, which caters to a diverse patient population from urban and semi-urban regions of Maharashtra. An institutional review board approval was obtained before the commencement of the study (Letter # ADM/ 2022-2023/401). Sixty participants over 18 years of age, with a duration of T2DM greater than four years and diagnosed according to the American Diabetes Association criteria, were included.<sup>16</sup> Patients with thrombocyte counts <100 or >400×10<sup>3</sup>/μl; those taking

medications affecting thrombocyte function (aspirin, warfarin, ticlopidine, heparin, or statins); individuals with hemoglobinopathies, pregnancy, hemoglobin levels <12 g/dl in men or <10 g/dl in women; and those with a history of smoking, chronic liver disease, or dyslipidemia were excluded to minimize confounding factors influencing mean thrombocyte volume (MTV). The procedures follow the guidelines laid down in the Declaration of Helsinki. A sample size of 60 patients was estimated using the formula given, based on the findings of Razak et al, who reported a correlation coefficient of 0.58, which provided 90% power at a 5% significance level between MTV and albuminuria.<sup>14,17</sup>

$$n = [(Z\alpha + Z\beta)/C]^2 + 3$$

$$C = 0.5 \times \ln[(1 + r)/(1 - r)]$$

A detailed history and clinical examination were conducted. The duration of diabetes was documented, and a complete blood count was obtained using an automated blood cell analyzer. Urine microalbumin was assessed by the bromocresol purple method. HbA1c was measured by high-performance liquid chromatography. The primary objective and secondary objectives were to find a correlation between MTV and microalbuminuria and between MTV and the duration of T2DM and HbA1c, respectively. The data on discrete variables are shown as n (%), and the data on normally distributed continuous variables are presented as mean and standard deviation (SD). The normally distributed quantitative variables of the two and three groups were tested by an unpaired t-test and analysis of variance (ANOVA), respectively. The Pearson correlation analysis was done to find the correlation.

**RESULTS**

In the present hospital-based cross-sectional observational study, 75 patients were assessed for eligibility. Fifteen patients were excluded: 3 male patients with haemoglobin <12 g/dl, 5 female patients with haemoglobin <10 g/dl, and 7 patients due to the use of aspirin and/or statins. Sixty patients were included in the present study. The demographic and clinical profile of the study population is depicted in Table 1. There was a marked association between MTV and DM duration, HbA1c and urine microalbumin. The mean MTV was markedly elevated in patients with DM duration of more than 10 years, HbA1c >7% and urine microalbumin >30 mg/g (Table 2). The MTV was significantly correlated with age, the duration of DM, HbA1c, urine microalbumin, and thrombocyte count (Table 3).

**Table 1: Demographic and clinical profile of the study participants.**

Variables	N (%)
<b>Age groups in years</b>	
<40	3 (5.0)
40-50	11 (18.3)

Continued.

Variables	N (%)
50-60	26 (43.3)
60-70	15 (25.0)
≥70	5 (8.3)
Mean age in years±SD	55.5±9.3
<b>Gender</b>	
Males	24 (40.0)
Females	36 (60.0)
Mean duration of DM±SD in years	10.6±4.8
<b>Duration of DM in years</b>	
<5	10 (16.7)
5–10	26 (43.3)
>10	24 (40.0)
<b>HbA1c (%)</b>	
≤7.0	23 (38.3)
>7.0	37 (61.7)
<b>Urine microalbumin (mg/g)</b>	
<30 (normal to mildly increased)	24 (40.0)
30–300 (moderately increased)	20 (33.3)
>300 (severely increased)	16 (26.7)

SD – Standard deviation, DM – diabetes mellitus

**Table 2: Association of MTV with the duration of diabetes mellitus, HbA1c and urine microalbumin.**

Variables	Mean MPV±SD in fL	P value
<b>Duration of DM in years</b>		
<5	7.22±0.75	0.001*
5-10	7.44±0.96	
>10	8.52±0.79	
<b>HbA1c %</b>		
≤7	6.86±0.50	0.001**
>7	8.42±0.78	
<b>Urine microalbumin mg/g</b>		
<30	6.86±0.48	0.001*
30-300	7.92±0.29	
>300	9.14±0.57	

\*Analysis of variance test was used, \*\*an unpaired t-test was used, MTV – mean thrombocyte volume, SD – standard deviation

**Table 3: The correlation between MTV and other variables.**

Variables	Correlation with MPV						
	Age	Duration of DM	HbA1c	Urine microalbumin	Platelet count	Hb	MCV
<b>R-value</b>	0.433	0.552	0.875	0.936	0.878	-0.060	0.004
<b>P value</b>	0.001	0.001	0.001	0.001	0.001*	0.651	0.977

Pearson correlation analysis was used, MTV – mean thrombocyte volume, DM - diabetes mellitus, MCV – mean corpuscular volume, Hb - haemoglobin

**DISCUSSION**

The present hospital-based cross-sectional observational study found a significantly high relationship between MTV levels with DM duration, HbA1c and microalbuminuria in T2DM patients. In the present study, the mean±SD of the age was 55.5±9.3 years. Razak et al, Khanna et al, Brahmbhatt et al, Alzahrani et al, and Bhattarai et al reported the average±SD age of the study participants was 57.55±9.91, 56.96±8.99, 53.96±12.17,

57.88±12.06, and 57.45±15.19 years, respectively.<sup>14,15,18-20</sup> In the present study, 24 cases (40.0%) were males. Razak et al, Khanna et al, Brahmbhatt et al, Alzahrani et al, and Bhattarai et al reported that 40.0%, 43.0%, 51.0%, 46.3%, and 42.11% were males, respectively.<sup>14,15,18-20</sup> In the present research, the mean±SD of the duration of DM was 10.6±4.8 years. Razak et al and Bhattarai et al reported that the mean±SD duration of DM was 15.42±7.61 years and 10.11±7.17 years, respectively.<sup>14,20</sup> In the present study, 23 cases (38.3%) had HbA1c levels less than or equal to 7.0%.

Razak et al reported that 32.0% of patients had HbA1c  $\leq 7.0\%$ , which is comparable to our findings.<sup>14</sup>

Augmented thrombocyte activity is theorized as a critical element in developing vascular complications in T2DM patients. Newer and more active thrombocytes, which can easily aggregate, have an elevated MTV, while less active thrombocytes have a lower MTV.<sup>20</sup> In our study, the mean $\pm$ SD of MTV was 6.86 $\pm$ 0.48 fL, 7.92 $\pm$ 0.29 fL and 9.14 $\pm$ 0.57 fL in patients' urine microalbumin below 30 mg/g, between 30–300 mg/g and above 300 mg/g, respectively ( $p=0.001$ ). The increased mean urinary microalbumin detected in this study may be attributed to suboptimal glycemic control, delayed recognition of diabetes, non-adherence to prescribed therapy, and late presentation for medical evaluation. Alzahrani et al reported that the mean MTV was 8.36, 8.6 and 8.69 fL in patients who had albuminuria  $<30$ , 30–300 and  $>300$  mg/g, respectively ( $p=0.157$ ).<sup>19</sup> Razak et al reported that the mean MTV was 7.0, 7.8 and 8.9 fL in patients who had albuminuria  $<30$ , 30–300 and  $>300$  mg/g, respectively ( $p=0.001$ ).<sup>14</sup> Joena et al observed that the average MTV among individuals with low urinary microalbumin ( $<30$  mg/g) was 7.716 $\pm$ 0.876 fL, whereas in those with elevated albuminuria ( $>30$  mg/g) it was 7.705 $\pm$ 0.890 fL ( $p=0.914$ ).<sup>21</sup>

In the current research, the mean MTV was 6.86 $\pm$ 0.50 and 8.42 $\pm$ 0.78 fL in patients for the controlled (HbA1c  $\leq 7.0\%$ ) and uncontrolled ( $>7.0\%$ ) DM groups, respectively ( $p=0.001$ ). Alzahrani et al noted that the mean MTV was 8.45 and 8.42 fL in patients who had HbA1c  $<7$  and  $>7$ , respectively ( $p=0.808$ ).<sup>19</sup> Ünübol et al stated that the mean MTV $\pm$ SD was 8.71 $\pm$ 1.16 and 8.7 $\pm$ 1.16 fL for the controlled (HbA1c  $\leq 7.0\%$ ) and uncontrolled ( $>7.0\%$ ) DM groups, respectively ( $p>0.05$ ).<sup>22</sup> Razak et al observed that the mean MTV was 6.9 $\pm$ 1.0 and 8.1 $\pm$ 1.1 fL in patients who had HbA1c  $\leq 7$  and  $>7$ , respectively ( $p=0.001$ ).<sup>14</sup>

In the current research, the mean $\pm$ SD of MTV was 7.22 $\pm$ 0.75 fL, 7.42 $\pm$ 0.96 fL and 8.52 $\pm$ 0.79 fL in a group of cases with a duration of DM less than five years, between five and ten years, and more than ten years, respectively ( $p=0.001$ ). Joena et al reported that the mean MTV in individuals with a duration of diabetes of  $<5$ , 6–10, and  $>11$  years was 7.722 $\pm$ 0.882, 7.663 $\pm$ 0.831, and 7.718 $\pm$ 0.929 fL, respectively ( $p>0.05$ ).<sup>21</sup>

A significant positive correlation of 0.936, 0.552, 0.875 and 0.433 was observed in our study between MTV and urine microalbumin levels, the duration of DM, HbA1c and age, respectively ( $p=0.001$  for each). A study conducted in Jeddah, Saudi Arabia reported that MTV was negatively correlated with age (correlation coefficient= $-0.112$ ,  $p=0.014$ ), HbA1c (correlation coefficient= $-0.036$ ,  $p=0.433$ ), albuminuria to creatinine ratio (correlation coefficient= $-0.049$ ,  $p=0.331$ ) and DM duration (correlation coefficient= $-0.117$ ,  $p=0.102$ ).<sup>19</sup> A study conducted in Vadodara, Gujarat, India, observed a correlation of 0.6521, 0.5649, 0.5712 and 0.6627 between

MTV and DM duration, fasting BSL, postprandial BSL, and HbA1c, respectively.<sup>15</sup> Research carried out by Joena et al in Madurai, Tamil Nadu, India stated that there was a moderate, markedly positive relationship of HbA1c level with MTV (correlation coefficient= $-0.198$ ,  $p=0.001$ ). A study conducted in Baghdad, Iraq, stated that MTV had a statistically significant positive relationship with albuminuria (correlation coefficient= $0.580$ ,  $p=0.001$ ), age (correlation coefficient= $0.209$ ,  $p=0.037$ ), DM duration (correlation coefficient= $0.426$ ,  $p=0.001$ ), HbA1c (correlation coefficient= $0.358$ ,  $p=0.001$ ), thrombocyte count (correlation coefficient= $0.282$ ,  $p=0.005$ ), random BSL (correlation coefficient= $0.472$ ,  $p=0.001$ ).<sup>14</sup> Ünübol et al conducted a study in Türkiye and reported a positive correlation between MTV and microalbuminuria levels (correlation coefficient= $0.14$ ,  $p=0.009$ ), but found no significant relationship between HbA1c and MTV levels (correlation coefficient= $-0.36$ ,  $p=0.64$ ).<sup>22</sup> Demirtunc et al observed that the relationship between MTV and HbA1c was 0.394.<sup>23</sup> In our study, haematological variables such as haemoglobin levels and the mean corpuscular volume did not show a statistically significant correlation with MTV ( $p>0.05$  for both). This is comparable to the studies of Razak et al, Brahmhatt et al, and Alzahrani et al.<sup>14,15,19</sup>

### Limitations

Although the sample size was modest, it was statistically powered to detect a significant correlation between mean thrombocyte volume and microalbuminuria, aligning with previous research. The cross-sectional design was appropriate for exploring associations within a defined population, but longitudinal studies would further clarify whether changes in thrombocyte indices precede diabetic microvascular complications.

### CONCLUSION

The mean MTV was significantly elevated in participants with a DM duration of more than ten years, HbA1c  $>7\%$ , and urine microalbumin  $>30$  mg/g. A strong correlation was observed between MTV levels and diabetes duration, HbA1c, and microalbuminuria in patients with T2DM. MTV serves as an easy-to-perform and economical tool for assessing diabetes management and detecting its associated kidney complications.

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