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Original Research Article

The Significance of Mean Platelet Volume in Type 2 Diabetes Patients

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Abstract:

Background and Aim: Diabetes mellitus has emerged as a significant global health crisis. Heightened platelet activity could contribute to the emergence of vascular complications associated with this metabolic disorder. The mean platelet volume (MPV) serves as a crucial marker for assessing the average size and functionality of platelets. Research indicates that larger platelets are typically younger and demonstrate increased activity levels. This study focused on comparing mean platelet volume (MPV) in patients with Type 2 Diabetes against non-diabetic controls. It also examined the relationship between MPV and vascular complications in diabetic individuals, as well as the correlation of MPV with diabetes duration, HbA1C levels, and fasting blood sugar levels.

Material and Methods: A comparative cross-sectional study involving 300 participants, consisting of 150 diabetic patients and 150 nondiabetic controls, was conducted at a tertiary care institute in Gujarat. The analysis of MPV was conducted in both groups, examining its potential association with diabetic complications and glycaemic parameters.

Results: The findings indicate that mean platelet volume (MPV) levels were notably elevated in individuals with diabetes when compared to the control group. In a similar vein, our findings indicated that individuals with diabetes who experienced vascular complications exhibited notably elevated MPV levels when contrasted with their counterparts who did not have such complications. In individuals with diabetes experiencing microvascular complications, there is a notable correlation between Mean Platelet Volume (MPV) and both Diabetic Nephropathy and Diabetic Retinopathy. In a similar vein, individuals experiencing macrovascular complications exhibited a notable correlation between Mean Platelet Volume and Peripheral Artery Disease.

Conclusion: The findings indicate a notable association between fluctuations in mean platelet volume and diabetes, along with its associated complications. The affordability, accessibility, and clarity of this tool position it as a valuable indicator for identifying thromboembolic events and mitigating vascular damage in individuals with type 2 diabetes.

Keywords: Diabetes mellitus, Glycaemic Parameters, Mean Platelet Volume, Peripheral Artery Disease.

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Introduction

Diabetes mellitus (DM) represents a significant challenge to public health worldwide. [1,2] In 2011, the World Health Organisation estimated that 346 million individuals were living with diabetes globally. [3] Type 2 diabetes mellitus is a component of metabolic syndrome, which includes dyslipidaemia, hypertension, impaired fibrinolysis, and elevated procoagulation factors. [4,5]

Vascular disorders, including coronary arterial disease, significantly increase the morbidity and mortality associated with type 2 diabetes mellitus. [6] Type 2 diabetes mellitus is associated with the development of atherosclerosis, impaired circulation, and disruptions in coagulation regulation. [7] Research indicates a relationship between cardiovascular mortality risk and blood glucose levels in individuals with type 2 diabetes mellitus. Hyperglycemia is believed to negatively impact the blood vessels. [8]

Heightened platelet activity is highlighted as a contributing factor in the emergence of vascular complications associated with this metabolic disorder. Mean platelet volume (MPV), an important indicator of platelet function and activation, is assessed using haematology analysers to measure platelet volume. Individuals with diabetes face a heightened risk of both microvascular and macrovascular complications,

with emerging evidence suggesting that platelets could play a significant role due to changes in their morphology and functionality.[9,10] Proangiogenic factors such as serotonin and thromboxane A2 are released in higher amounts by larger activated platelets compared to their smaller counterparts. [11] The interplay of hyperglycemia, insulin resistance, oxidative stress, hyperlipidaemia, and various metabolic disorders is crucial in the development of endothelial damage and heightened platelet activation. Large activated platelets adhere to the injured endothelial cells and cluster in that area due to a decreased responsiveness of the platelets to nitric oxide, heightened production of von Willebrand factors by the compromised endothelial cells, and increased concentrations of advanced glycation end products. The process triggers thrombus formation and microcapillary embolisation, ultimately contributing to the emergence of vascular lesions. [12] This suggests a connection between platelet function and vascular injury in individuals with diabetes, a leading contributor to both morbidity and mortality associated with the disease. This study focused on comparing mean platelet volume (MPV) in patients with Type 2 Diabetes against non-diabetic controls. It evaluated the relationship between MPV and vascular complications in those with diabetes, while also examining how MPV correlates with the duration of diabetes, HbA1C levels, and fasting blood sugar levels.

Material and Methods

A comparative cross-sectional study was conducted over the course of one year. The study employed a non-purposive sampling technique. The calculation of sample size was conducted utilising a standard formula grounded in the normal distribution, specifically for the purpose of comparing two mean sections. The participants were sourced from the Out-patient Department within the Department of Medicine and subsequently classified into two distinct groups: 1) Individuals diagnosed with type 2 Diabetes Mellitus and 2) Age and sex matched controls (those who exhibit no symptoms or laboratory findings indicative of diabetes and have no known vascular complications, but have sought medical attention for other health concerns). Our study excluded patients with vascular comorbidities and those who were on anticoagulant medications. All participants provided their consent. All participants underwent thorough clinical evaluations.

A total of three hundred (300) participants took part in our study, which included one hundred and fifty (150) individuals with established cases of type 2 diabetes mellitus and one hundred and fifty (150) age and gender-matched controls.

Patients with diabetes underwent a series of investigations, including fasting blood sugar tests, HbA1C assessments, and complete blood counts (which included mean platelet volume), while the control groups were limited to complete blood counts (also including mean platelet volume). Nevertheless, a comprehensive history was gathered from these controls. Control patients were selected exclusively from those who exhibited no signs or symptoms, nor any recent investigation reports indicative of diabetes or vascular complications. The haematological and biochemical analyses were conducted in the designated laboratories of the Study Hospital.

All diabetic patients underwent examinations to identify any associated microvascular complications affecting the kidneys, eyes, and nerves. In a similar vein, these patients underwent evaluations for macrovascular complications, including Coronary Artery Disease (CAD), Peripheral Arterial Disease, and Diabetic Foot issues.

The clinicians from the relevant disciplines assessed and validated these complications, for instance. An ophthalmologist conducted an evaluation of diabetic retinopathy. The information was gathered through a thorough examination of the patients' medical histories. Diabetic patients were categorised into two distinct groups depending on the presence or absence of complications: one group comprising those with complications and the other consisting of those without. In order to assess the relationship between glycaemic control and mean platelet volume (MPV), participants with diabetes were divided into two groups according to their HbA1C levels: A patient presenting with a HbA1C level of 7%. The chosen cut-off point aligns with the American Diabetes Association's 2019 criteria, which recommend a reasonable HbA1C goal for adults to be below 7.5. In order to assess how the duration of diabetes influences Mean Platelet Volume, the diabetic participants were categorised into two distinct groups: A person who has been living with diabetes for five years.

In a controlled environment, two millilitres of whole blood were collected in an EDTA vacutainer for the analysis of Mean Platelet Volume and HbA1C, while an additional five millilitres of whole blood were drawn in a plain vacutainer for fasting blood sugar testing. Samples were gathered from the participants following a thorough explanation of the study and the acquisition of their written consent. The serum was isolated through centrifugation at 3000 rpm for a duration of 12 to 15 minutes, conducted at an ambient temperature of around 25◦C. All tests were conducted shortly after the samples were collected. The complete blood count, which includes the mean platelet volume

(MPV), was analysed using a haematology analyser. Measurements were taken for biochemical parameters, including fasting blood sugar (FBS) and HbA1C levels.

Statistical analysis

The collected data was organised and input into a spreadsheet application (Microsoft Excel 2019) before being transferred to the data editor interface of SPSS version 19 (SPSS Inc., Chicago, Illinois, USA). Quantitative variables were characterised using means and standard deviations or medians and interquartile ranges, depending on their distribution patterns. Qualitative variables were reported in terms of counts and percentages. The confidence level for all tests was established at 95%, while the level of significance was determined to be 5%.

Results

A total of three hundred subjects took part in our study, comprising one hundred and fifty individuals with diagnosed type 2 diabetes mellitus and one hundred and fifty age- and gender-matched controls. The diabetic cohort was categorised according to the presence or absence of vascular complications, the duration of the condition, and HbA1C levels. In line with the worldwide trend of undiagnosed early diabetes and the postponement of hospital visits among Type 2 Diabetics, our study revealed that a significant number of diabetics exhibited complications associated with a longer duration of diabetes and elevated HbA1C levels, indicating inadequate glycaemic control. In the population of diabetics experiencing complications, patients were categorised according to various forms of microvascular and macrovascular issues. In our study, diabetic nephropathy emerged as the predominant microvascular complication, affecting 35 individuals, while retinopathy and neuropathy followed, impacting 25 and 14 individuals, respectively. On the macrovascular side, coronary artery disease was the most prevalent complication, observed in 28 participants, with peripheral artery disease and diabetic foot complications noted in 8 and 3 individuals, respectively.

In the diabetic population, MPV levels were notably elevated when compared to the control group. In a similar vein, our findings revealed a notably elevated mean platelet volume (MPV) in diabetics who experienced vascular complications when compared to their counterparts without such complications.

In individuals with diabetes experiencing microvascular complications, there is a notable correlation between Mean Platelet Volume (MPV) and both Diabetic Nephropathy and Diabetic Retinopathy, as illustrated in Table 3. In a similar vein, individuals experiencing macrovascular complications exhibited a notable correlation between Mean Platelet Volume and Peripheral Artery Disease. In our study, we observed a notable positive correlation between MPV and HbA1C, fasting blood sugar, and the duration of diabetes. The positive "r" values indicate that all three correlations are present.

Table 1: Age distribution of participants

Mean Age	Mean	SD
Diabetes Cases	57.97	09.28
Non-Diabetes (Control)	57.25	10.04

Table 2: Gender wise Distribution of Study Participants

Gender	Diabetes Cases Number (%)	Non-Diabetes (Control) Number (%)
Male	86 (57.3)	90 (60)
female	64 (42.66)	60 (40)
Total	150 (100)	150 (100)

Table 3: Comparison of mean platelet volume among diabetic patients with microvascular complication

Mean platelet volume	Nephropathy	Retinopathy	Neuropathy
Increased	12.80	12.89	12.48
Not Increased	11.79	11.91	12.01

Discussion

Type 2 diabetes mellitus is a multifaceted metabolic disorder marked by persistent high blood sugar levels, which can lead to a range of complications affecting both microvascular and macrovascular systems, including conditions like retinopathy, nephropathy, and coronary artery disease. Insulin resistance and compromised insulin secretion play a crucial role in the development of type 2 diabetes mellitus. Demirtunc R et al. indicated that a higher HbA1c level correlates with an increase in MPV.

The researchers suggested that improved glycaemic control may lead to a reduction in mean platelet volume (MPV), potentially mitigating the involvement of platelets in cardiovascular events

associated with type 2 diabetes mellitus. [13] Kodiatte et al. proposed a connection between mean platelet volume (MPV) and retinopathy, independent of the duration of diabetes. [14] In our study, we observed that the mean platelet volume (MPV) is elevated in individuals with type 2 diabetes mellitus. Furthermore, there was a direct correlation between increased MPV and both elevated HbA1c levels and the duration of diabetes. A recent study highlights that both HbA1c levels and the duration of diabetes have independently contributed to cardiovascular complications in adolescents diagnosed with type 2 diabetes mellitus. [15]

Numerous mechanisms have been suggested to elucidate the critical role that metabolic abnormalities associated with type 2 diabetes have in the onset of diabetic vascular complications. The factors at play include (i) diminished Nitric oxide production by impaired endothelial cells alongside heightened endothelin-1 production, leading to vasoconstriction, (ii) the activation of genes that elevate the production of mediators associated with atherogenesis, (iii) reduced collagen production contributing to the development of unstable plaque, and (iv) changes in platelet function that facilitate thrombus formation. [16] Insulin typically plays a crucial role in inhibiting thrombus formation by blocking the interaction between platelets and collagen. Insulin resistance observed in individuals with type 2 diabetes contributes to heightened thromboembolic activity, which can subsequently lead to the emergence of vascular complications. [17] The average volume of platelets is crucial for assessing platelet size, which facilitates the identification of large aggregable platelets involved in thrombus formation.

In our study, we observed a significant increase in MPV among individuals with diabetes when compared to non-diabetic controls. This aligns with the findings of the majority of studies conducted, including our own. [18-20] The presence of these large hyperactive platelets suggests their formation is a consequence of chronic hyperglycemia. Chronic high blood sugar levels facilitate the entry of glucose into platelets, leading to glycogen synthesis within these cells and contributing to an increase in mean platelet volume (MPV). [21] Several studies have reported that the mean MPV in diabetic patients does not significantly differ from that of non-diabetic controls, which stands in contrast to our findings. [18,21,22] In our study, we examined Diabetes patients who experience complications in contrast to those who do not.

MPV levels were notably elevated in individuals experiencing complications. Comparable results were observed in most studies conducted in a manner akin to ours. [23-27] This indicates that a heightened activity of platelets is significant in the progression of vascular complications. The heightened production of thromboxane A2, stemming from procoagulant effects, contributes to thrombotic vascular complications. This results in larger platelets exhibiting increased hyperactivity and a greater tendency to aggregate compared to their smaller counterparts. This stood in contrast to several studies No significant difference in MPV was observed between patients with diabetic complications and those without complications, as indicated by the findings. [11,20]

Mean Platelet Volume (MPV) serves as a crucial marker reflecting both the average size and functional activity of platelets in the bloodstream. Larger platelets tend to be younger, exhibiting increased reactivity and a greater propensity for aggregation. Consequently, these larger platelets possess a greater concentration of granules, release increased amounts of serotonin and β-thromboglobulin, and generate higher levels of thromboxane A2 compared to their smaller counterparts. These factors can lead to a pro-coagulant effect, potentially resulting in thrombotic vascular complications.

This indicates a connection between platelet function, particularly mean platelet volume (MPV), and vascular complications associated with diabetes, suggesting that variations in MPV may mirror the state of thrombogenesis. Small bleeds may occur as a result of the rupture of atherothrombotic plaques, which can lead to heightened platelet recruitment, increased reactivity, and stimulation of the bone marrow. Elevated MPV is increasingly recognised as a significant risk factor for the vascular complications associated with diabetes mellitus, particularly in the context of atherothrombosis. Diabetes mellitus is recognised as a condition that promotes a heightened risk of thrombosis, characterised by increased platelet activity. Research indicates that platelet hyperactivity is observed in individuals with diabetes as well as in animal studies, both in living organisms and in laboratory settings. [28,29]

Our research revealed a notable increase in mean platelet volume (MPV) among patients with diabetic nephropathy, aligning with findings from numerous similar studies. [29-32] Our research indicates that patients with diabetic retinopathy exhibited notably elevated levels of MPV. The findings align with numerous other studies that have been conducted in a similar manner to ours. [30-33] In our study, the link between MPV and various microvascular complications, including retinopathy and nephropathy, is elucidated by the findings of Cakir L et al. [34] This study reveals that a modified signalling pathway enhances platelet activation and aggregation when exposed to a particular stimulus. This process contributes to

thrombus formation and micropapillary embolisation, accompanied by the release of constrictive, oxidative, and mitogenic substances such as PDGF and VEGH. These changes accelerate the development of local vascular lesions, including the neovascularisation of the lens in cases of diabetic retinopathy. In our study, while diabetic patients with neuropathy exhibited a larger mean platelet volume, the increases observed were statistically insignificant. This finding contradicts several studies that reported significantly elevated MPV levels in diabetics experiencing severe neuropathy, as indicated by an NDS greater than 6, compared to those with an NDS lower than this threshold. Our study revealed a significant positive association between mean platelet volume and fasting blood sugar levels. Comparable findings were observed in additional research conducted alongside ours. [19,31,35] A noteworthy positive correlation was observed between MPV and HbA1C levels. The findings align with several other studies in the field. [19,21,32-35] One potential explanation for this phenomenon is that individuals with diabetes who exhibit poor glycaemic control may experience hyperactive platelets, a condition potentially linked to the glycation of platelet membrane proteins. This results in the premature breakdown of platelets and an increase in thrombopoiesis, ultimately leading to a higher mean platelet volume (MPV). Our research indicated a significant positive correlation between MPV and the duration of diabetes. The findings align with the majority of comparable studies in the field. Twenty-five to thirty Yeom E et al. [36] discovered that an extended duration of diabetes leads to endothelial dysfunction, which in turn results in heightened platelet activation and aggregation. Findings indicate that patients with a longer history of diabetes may show elevated MPV values. The study faced limitations in assessing qualitative platelet disorders and other reactive causes for elevated platelet levels, such as menstruation, which play a relatively minor role.

Conclusion

Increased in mean platelet volume are closely associated with diabetes and its associated complications. This approach is cost-effective, readily available, and easy to understand, positioning it as a valuable tool for identifying thromboembolic events and mitigating vascular damage in individuals with type 2 diabetes.

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