

Clinical Significance of Mean Platelet Volume in Predicting Mortality and Complications Following Cerebrovascular Accident

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ABSTRACT

Stroke is a major global health concern associated with significant morbidity and disability. Mean platelet volume (MPV), an indicator of platelet activation, has been proposed as a potential biomarker for assessing disease severity in acute stroke patients. To determine the association between MPV and acute stroke, and to correlate MPV with in-hospital morbidity. Over the course of eighteen months, this prospective observational study was carried out at a tertiary care facility in Tamil Nadu. One hundred acute stroke patients in all were included using convenient sampling. Data were collected using a structured proforma including demographic, clinical, and biochemical parameters. Stroke severity was assessed using the National Institutes of Health Stroke Scale (NIHSS), and MPV levels were measured and categorized. Jamovi software was used for statistical analysis, and $p < 0.05$ was deemed significant. The majority of patients were aged 41–60 years, with male predominance and ischemic stroke being the most common subtype. Most patients had mild to moderate stroke severity. Elevated MPV was observed in a subset of patients. A significant positive correlation was found between MPV and NIHSS score, indicating that higher MPV was associated with greater stroke severity. Additionally, MPV was significantly higher in patients with diabetes mellitus and chronic kidney disease. MPV is significantly associated with stroke severity and may serve as a simple and cost-effective biomarker for assessing in-hospital morbidity in acute stroke patients.

Keywords: Mean platelet volume, Stroke, NIHSS, Platelet activation, Cerebrovascular accident

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1. INTRODUCTION

Stroke is now one of the world's leading causes of illness, as it causes a lot of death and long term disability. The number of stroke incidents keeps growing, and the number of ischemic strokes is more than 70% of all, thus being the most common type of cerebrovascular accidents (Abeles et al., 2019). The prevalence, neurological deficits, and permanent functional loss related to the disease lead to a huge socioeconomic burden (Balta et al., 2016). The pathophysiology of acute ischemic stroke has its underlying causes that are largely ascribed to atherothrombotic events in which the impairment of cerebral blood flow causes ischemia and injury to neurons. Platelet activation is also important in this process and it helps in the formation of thrombus and vascular blockage (Bozan et al., 2016). The platelet aggregation, fibrin formation, and fibrinolysis balance define the course and extent of the ischemic injury (Buch et al., 2017). Platelets also vary in size, density and reactivity, variation which is indicated in Mean platelet volume (MPV). The size and activity of the platelets are determined by MPV, where larger platelets are more active in their metabolism and enzymatic activity (Budak et al., 2016). These giant platelets carry more prothrombotic factors like thromboxane B₂,

serotonin, and surface glycoproteins which augment platelet aggregation and thrombus formation (Chen et al., 2019). The importance of MPV in the clinical scenario has recently been identified and can be discussed as a potential biomarker in different cardiovascular and inflammatory disorders. High MPV was linked to high risk of thrombosis and bad clinical outcomes (Chen et al., 2021). MPV is reported to be associated with the severity and prognosis of cardiovascular diseases, which implies that the marker can be used as an affordable and readily available instrument (Choi et al., 2016). Moreover, MPV is also associated with structural and functional brain alteration, which means that it can be implemented in the neurological conditions (Choi et al., 2017). It has also been found to predict clinical outcomes in such critical conditions as cardiac arrest where the increased MPV levels were correlated with poor prognosis (Chung et al., 2016). These results confirm the assumption that MPV could be a valuable predictor of platelet activation and severity of diseases in acute stroke.

Although the evidence on the application of MPV in thrombotic and inflammatory conditions continues to increase, its clinical application in acute stroke is not conclusive. There is some evidence that MPV is a

powerful prognostic marker and inconsistent or non-significant results are noted by other studies (Çiçek et al., 2016). Such variability was explained by the variation in the design of the study, population attributes, measurement methodologies. Also, the majority of the existing researches have been centered on cardiovascular diseases, and there has been insufficient emphasis on cerebrovascular ailments. More recent studies have investigated the relationship between MPV and in-hospital outcomes in myocardial infarction, but analogous extensive assessments in stroke patients have not been carried out (Demir et al., 2023). More than that, despite the link of MPV with short-term outcomes in acute coronary syndromes, the role of this biomarker in the probability of severity and complications in stroke remains to be studied (Ekmekci et al., 2024). Inflammatory states also affect MPV and make the interpretation of the independent variable difficult (Korniluk et al., 2019). In addition, little prospective observation data are used to evaluate MPV against clinical severity scales, with the National Institutes of Health Stroke Scale (NIHSS). It is imperative to make such correlations to confirm that MPV is a viable prognostic instrument (Lee et al., 2018).

The existing treatment methods of acute ischemic stroke such as thrombolysis and mechanical thrombectomy are not equally effective to all patients. Despite early treatment, most patients do not show good results, which is why more effective prognostic variables are required (Liu et al., 2018). MPV is a simple and cheap laboratory variable that could be used as an early indication of stroke severity and outcome. Past research proposed that the elevated amount of MPV correlates with the augmented platelet functions and the adverse clinical results in acute ischemic stroke (Lok et al., 2017).

Moreover, MPV has been investigated as a predictive variable in an array of clinical diseases, such as hypertensive disorders of pregnancy, which suggests its extended use as a predictive variable in the risk stratification (Mannaerts et al., 2019). Moreover, high MPV has been associated with procoagulant conditions like diabetes mellitus that are known to predispose and enhance the occurrence and severity of thrombotic events (Nimmala et al., 2024). Consequently, the assessment of MPV on acute stroke patients can be considered a source of useful data on the severity of the disease, its complications, and prognosis.

Research Objectives

1. To determine the association between MPV and Acute stroke.
2. Correlate MPV in association with in hospital morbidity and mortality.

2. METHODOLOGY

2.1 Study Design, Setting, and Duration

The study was conducted as an observational prospective study at a tertiary care facility in Chennai, Tamil Nadu. The researchers conducted the study during the total period of 18 months, namely, November 2023 to May 2025,

where patients who were admitted with acute stroke were evaluated and followed throughout their stay in the hospital.

2.2 Study Population and Sampling

Total of 100 patients whose group was admitted with acute stroke diagnosis for the study. The selection of participants occurred using the method of convenient sampling whereby all patients were recruited in the sample provided they were suitable and available in the hospital and met the inclusion criteria.

2.3 Exclusion and Inclusion Criteria

Patients who suffered acute stroke who were over the age of 18 and who gave informed permission for involvement were included. Patients with a history of stroke, known bleeding or clotting issues, pregnancy, refusal to give consent to participate in the study.

2.4 Variables and data collection

The collection of the information was conducted by the means of a structured questionnaire that comprised demographic data, clinical examination results, and the information regarding biochemical investigation. The participants were assessed throughout their stay at the hospital since the period of admission till discharge. MPV was measured and categorized and stroke severity was measured with NIHSS. In this, MPV was believed to be the independent variable and the severity of stroke measured using the NIHSS score was assumed to be the primary outcome variable. Other variables that were evaluated were the age, gender and comorbid ailments such as diabetes mellitus, coronary artery disease, chronic kidney disease and hypertension.

2.5 Statistical Analysis

The obtained data were processed with Jamovi software version 2.3.28. The data was summarized using descriptive statistics such as mean SD, frequency, and percentage. The appropriate tests like Pearson correlation and Student t-test were applied to inferential statistical analysis to determine the association between variables. The p-value of all analyses was set to be below 0.05 as the statistically significant level.

3. RESULTS

One hundred patients having acute stroke were incorporated into the research and assessed on demographic, clinical, and laboratory variables that were pertinent to MPV and stroke severity.

3.1 Study Population's Baseline Characteristics

The distribution of the study contributors according to age, gender, and type of stroke showed that, Most patients were in the age category of 41-60 years, comprising 53 per cent of the research population, then patients who were over 60 years (40%), and 21-40 years (7%) (Table 1). Males assumed preponderance, with 63% of the members being male and of 37% female. Regarding the nature of the stroke, ischemic stroke was

the most frequent presentation as it was observed in 86 per cent of the patients, compared to hemorrhagic, which was observed in 14 per cent of the patients. These results show that the study population was mainly male, aged

middle-aged to elderly and ischemic stroke was the most common subtype of stroke (Table 1).

Table 1. Baseline Profile

Category	Variable	\ n=100	Percentage (%)
Age	21–40	7	7.0%
	41–60	53	53.0%
	>60	40	40.0%
Gender	Male	63	63.0%
	Female	37	37.0%
Type of Stroke	Ischemic stroke	86	86.0%
	Hemorrhagic stroke	14	14.0%

Figure 1 demonstrates the distribution of the study participants regarding age, gender and type of stroke.

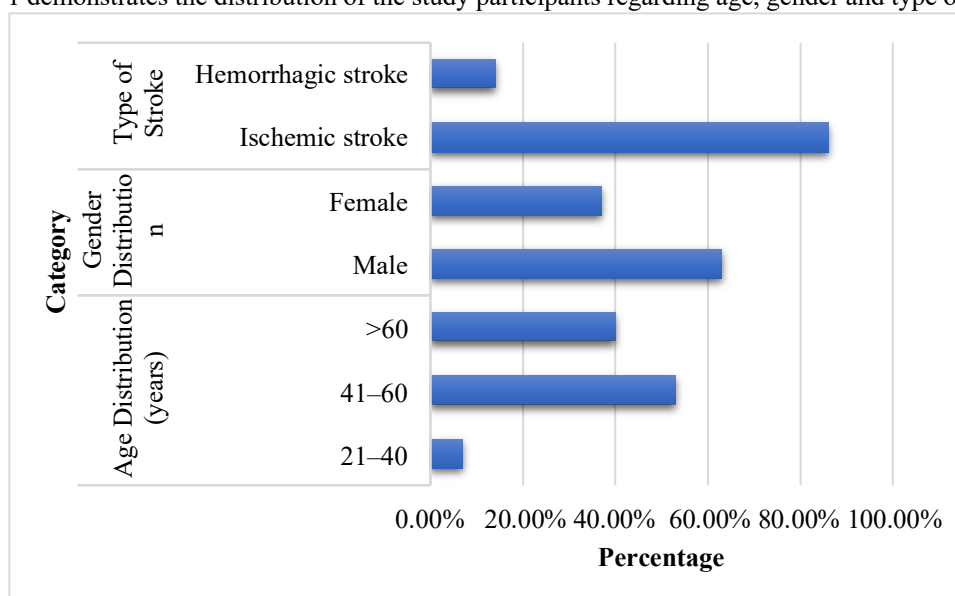


Figure 1. Baseline characteristics of study participants

The population as indicated in Figure 1 was mainly made up of middle aged and older people. Male participants were more than the female participants. Ischemic stroke was the prevalent one among the study participants and less frequently, hemorrhagic stroke was observed.

3.2 Distribution of Stroke Severity (NIHSS Score)

The extent of stroke had been measured on the NIHSS (Table 2). Most of the patients were moderate stroke severity (53% of the study population), then there was

mild stroke (44% of patients). Only 3% of cases were observed to have severe stroke and none of the patients were in the very severe category. Such results indicate that the proportion of patients who were admitted with mild to moderate neurological functioning was high, and many patients were comparatively less severe in their illness. The given NIHSS score was, therefore, a good indicator of in-hospital morbidity and clinical condition of the patients (Table 2).

Table 2. Distribution of Stroke Severity Based on NIHSS Score

NIHSS Category	Number of Patients	Percentage (%)
Mild (1–4)	44	44%
Moderate (5–15)	53	53%
Severe (16–20)	3	3%
Very severe (>21)	0	0%
Total	100	100%

3.3 MPV Profile

MPV distribution of the participants of the study is represented in Table 3. Most of the patients (86%) had normal range of MPV whereas the rest had high MPV levels exceeding 11.7 fL (Table 3). This shows that even in the majority of the patients, the MPV was within the normal range but a considerable percentage of the

patients showed high platelet volume, which could be an indicator of augmented platelet activation. The difference in MPV among the patients indicates that it may serve as a biomarker in acute stroke and could be related with the severity of the disease and its clinical outcomes.

Table 3. Distribution of MPV

MPV Category	Number of Patients	Percentage (%)
Normal (7.2–11.7 fL)	86	86%
High (>11.7 fL)	14	14%
Total	100	100%

Figure 2 gives the distribution of MPV of the study participants.

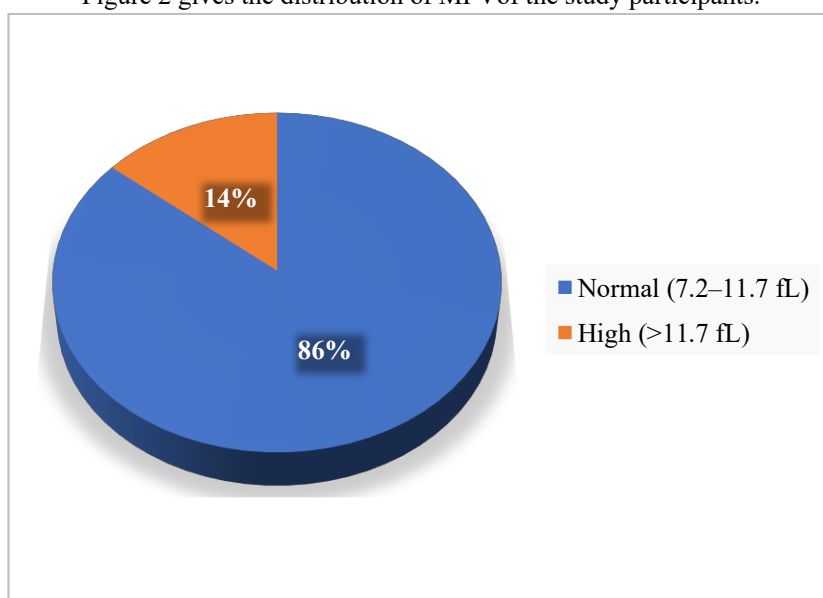


Figure 2. Distribution of MPV among study participants

Figure 2 indicates that the majority of the study participants experienced normal mean platelet volume, with minor proportionality representing high levels of the MPV in patients.

3.4 Correlation Between MPV and Stroke Severity

MPV versus stroke severity, correlation analysis was used to establish the association between the MPV and the severity of stroke as exhibited in Table 4. There was

a statistically significant positive correlation between MPV and NIHSS score with a correlation coefficient (r) of 0.464 and a value of less than 0.001. It means that in patients with increasing values of MPV, the severity of stroke, in terms of the NIHSS score, was increased. Such power and relevance of this association indicates that MPV can be used as a valuable measure of stroke severity and potentially predict in-hospital morbidity in patients with acute stroke (Table 4).

Table 4. Correlation Between MPV and NIHSS Score

Variable	r	df	p-value
MPV vs NIHSS	0.464	98	<0.001

3.5 Association of MPV with Comorbid Conditions

Table 5 represents the association between MPV and comorbid conditions of choice. The MPV value was meaningfully greater in patients with diabetes mellitus (10.6 ± 1.91 fL) than in patients without diabetes mellitus (9.14 ± 1.57 fL), the variance was statistically substantial ($p < 0.001$) (Table 5). In a similar manner, the MPV level was higher among the patients with chronic kidney disease (10.7 ± 2.32 fL) compared to the control group (9.69 ± 1.6 fL), which was statistically significant ($p = 0.013$). These results indicate that comorbidities that include diabetes mellitus and chronic kidney disease are related to more platelet activation, as indicated by higher MPV values, and may result in higher disease severity and unfavorable clinical outcomes in acute stroke patients.

Table 5. Association of MPV with Comorbid Conditions

Variable	Mean MPV (fL)	p-value
Diabetes (Yes)	10.6 ± 1.91	<0.001
Diabetes (No)	9.14 ± 1.57	
CKD (Yes)	10.7 ± 2.32	0.013
CKD (No)	9.69 ± 1.6	

Figure 3 shows the correlation between the MPV and comorbidity.

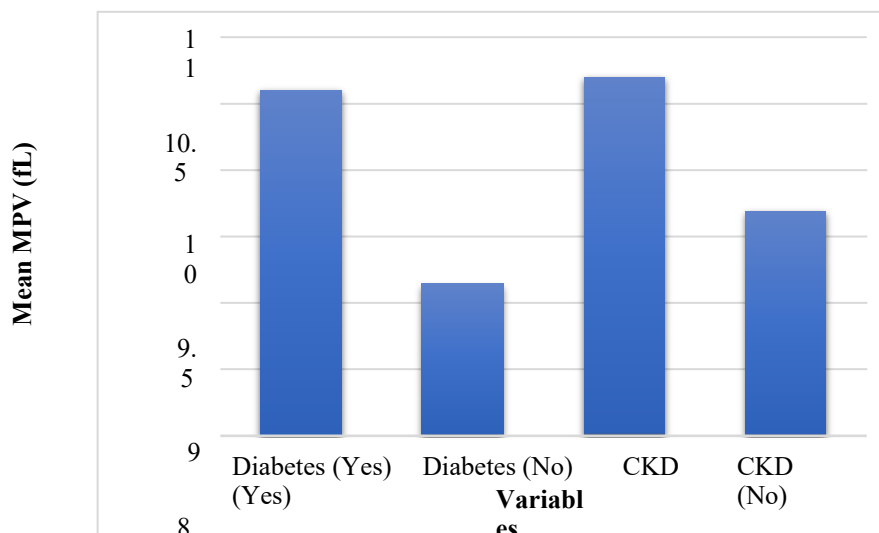


Figure 3. MPV in relation to diabetes mellitus and chronic kidney disease

As shown in Figure 3, MPV was greater in patients with diabetes mellitus than in patients with no diabetes. In the same manner, the MPV was higher among patients of chronic kidney disease than among those of no chronic kidney disease.

4. DISCUSSION

The study was performed to assess the clinical meaning of MPV in patients with an acute stroke and its correlation with the severity of the stroke. The results have shown that there was a positive correlation between MPV and the NIHSS score where a high level of MPV showed that the severity of stroke was more severe in the patients. This implies that MPV could be a valuable indicator of in-hospital morbidity among patients with acute stroke. The demographic characteristics of the study population revealed that the patients were mostly middle-aged to older adults, most of whom were male. The most common type that was prevalent among the participants was ischemic stroke. These results are in line with the overall epidemiological trend of stroke with ischemic stroke taking the major part of the cases and more prevalent in males and the elderly. The given distribution of the stroke severity showed that the prevalent stroke severity among the patients at the time of admission was mild to moderate, which means that the study population was composed of patients with less serious neurological impairment at the time of admission. The MPV analysis revealed that the majority of patients had normal levels of MPV, although a smaller

group of patients had a high level of MPV. Nevertheless, although most of them were of the normal range of MPV, a strong relationship was found between higher MPV and greater severity of the strokes. This implies that even slight increases in MPV can be of clinical use in the severity of stroke diagnosis. The fact that MPV and NIHSS score are positively correlated indicates the possibility that the size and activity of platelets would lead to an extravagant ischemic injury, which could be caused by a greater number of thromboses and vascular obstructions. The fact that MPV is associated with comorbid conditions also reinforces its clinical significance. The patients in this study with diabetes mellitus and chronic kidney disease showed a significant high value of MPV than those without the same. These data indicate that comorbidities can be a cause of platelet activation and show a role in the increased risk of thrombosis. These conditions can also increase the severity of the stroke, the level of which is represented by increased MPV. Therefore, MPV can be an appropriate indicator of stroke severity as well as the high-risk patient groups with comorbidities patients. The findings of the study are similar to the existing literature demonstrating the prognostic value of platelet indices in a number of clinical disorders. According to Pogorzelska et al. (2020), platelet indices, such as MPV, are highly valuable prognostic factors in diverse medical conditions, especially those that are associated with inflammatory and thrombotic activity. On the same note, Rupa-Matysek et al. (2018) also established platelet

activation on the basis of higher MPV being a predictor of increased thrombotic risk.

Sayed et al. were able to determine that platelet indices are good predictors of outcome in the critically ill, which further substantiates the use of MPV as a prognostic tool (Sayed et al., 2020). The clinical applicability of complete blood count parameters (MPV) has been supported by Seo and Lee (2022) and their importance in cardiovascular and metabolic diseases assessment. Furthermore, Shin et al. (2017) also indicated that higher MPV is linked to vascular complications, and thus it contributes to poor clinical outcomes. Tzur et al. (2019) also reported platelet indices as efficient prognostic factors in clinical practice, which also confirms the relevance of MPV in the severity of the disease and the prognosis.

These findings of the study indicate that MPV may be employed as an easy, cheap, and easily accessible biomarker to measure the severity of a stroke in the clinical practice. Because MPV is regularly checked in a complete blood count, it is easily added to the first assessment of patients with acute stroke. Clinicians can use the knowledge of patients who have a higher MPV in the earlier stages to ease the process of creating risk strategies and management plans. Also, the comorbid conditions including diabetes mellitus and kidney diseases associated with MPV underscore the value of evaluating the patients comprehensively to enhance the clinical outcome.

There are some limitations to this study that must be taken into account when explaining the findings. The research was also performed at one center and with a rather small population of 100, which can restrain the future extrapolation of the results. The study design was an observational one and thus, no causal associations between MPV and the severity of stroke can be made. In addition, no long-term follow-up was undertaken and the results like death, and post discharge complications were not reported. The severity of stroke was not measured at discharge but only during admission using the NIHSS score.

The results of the current study need to be confirmed by future research which will be multicentric and based on bigger samples. More detailed information would be obtained with longitudinal studies that evaluate the role of MPV in the determination of long-term outcomes, such as mortality and functional recovery. It is also necessary to conduct further studies to determine the role of MPV in the various subtypes of stroke and how it can be used in giving directives in the therapeutic interventions. Moreover, MPV could be used with other biomarkers to enhance its predictability and clinical use.

5. CONCLUSION

The study shows the clinical importance of MPV as a possible indicator of patients with acute stroke. There was a considerable positive association between the severity of the stroke measured by the NIHSS score and MPV, which showed that patients who have a high level of MPV have more severe impairment of the nervous

system. This conclusion implies that MPV can be a good predictor of in-hospital morbidity among patients with acute stroke. The research also indicated that there was a subgroup of patients who showed high MPV level and they were more prone to have higher levels of stroke. Moreover, there were large correlations between MPV and comorbidities like diabetes mellitus and chronic kidney disease, whereby patients with comorbidities had a high MPV level. It means that there can be some underlying metabolic and systemic disorders, which can be the source of the further platelet activation and, thus, more severe clinical manifestation. Even though the majority of patients were within the normal range of MPV, the correlation between MPV and the severity of stroke is high, which highlights the clinical importance of MPV. As a basic, affordable, and regularly offered laboratory parameter, MPV can be included in the preliminary assessment of stroke patients in order to produce early risk evaluation. Conclusively, MPV can be discussed as a useful biomarker to estimate stroke severity and risky patients and, therefore, facilitate better clinical decision-making and treatment of acute stroke.

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