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Small Cells, Big Clues: Mean Platelet Volume as a Marker in Acute Ischemic Stroke.

Dr. Darshan M [1], Dr. Abhishek TM [2], Dr. Bharathi S [3], Dr. Meghana VR [4]*.

[1]*Assistant Professor, Department of General Medicine, KVG Medical College & Hospital, Sullia, Karnataka, India.*

[2]*Senior Resident, Department of General Medicine, KVG Medical College & Hospital, Sullia, Karnataka, India.*

[3]*Assistant Professor, Department of General Medicine, JSS Medical College & Hospital, Mysuru, Karnataka, India.*

[4]*Assistant Professor, Department of General Medicine, East Point College of Medical Sciences, Bengaluru, Karnataka, India..*

Correspondence:
Dr. Meghana VR.
Assistant Professor, Department of General Medicine, East Point College of Medical Sciences, Bengaluru, Karnataka, India.

Email: meghanavr95@gmail.com

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Abstract

Background: Acute ischemic stroke (AIS) is a leading cause of mortality and long-term disability worldwide. Platelet activation plays a pivotal role in the pathogenesis of ischemic stroke, and mean platelet volume (MPV), an indicator of platelet size and activity, has emerged as a potential biomarker for assessing stroke severity and prognosis. This study aimed to evaluate the association between MPV and the severity of acute ischemic stroke, determine its relationship with neurological and functional outcomes, and assess its diagnostic performance in predicting severe stroke. ***Materials and Methods:*** A hospital-based observational cross-sectional study was conducted in the Department of General Medicine from May 2023 to May 2024. A total of 120 consecutive patients with radiologically confirmed acute ischemic stroke were enrolled. Demographic and clinical data, vascular risk factors, and laboratory investigations including MPV were recorded. Stroke severity was assessed using the National Institutes of Health Stroke Scale (NIHSS), while functional outcome was evaluated using the Modified Rankin Scale (mRS). Statistical analysis was performed using IBM SPSS Statistics version 26.0, with $p<0.05$ considered statistically significant. ***Results:*** The mean age of the study population was 64.3 ± 10.8 years, with males constituting 61.7% of participants. The mean MPV was 10.84 ± 1.23 fL. MPV increased significantly with increasing stroke severity ($p<0.001$) and demonstrated a strong positive correlation with NIHSS score ($r=0.684$, $p<0.001$). Patients with poor functional outcome had significantly higher MPV than those with favorable outcome (11.82 ± 0.96 vs. 10.18 ± 0.79 fL; $p<0.001$). ROC analysis showed good predictive accuracy for severe stroke (AUC=0.842), with an optimal MPV cut-off of >11.2 fL, yielding a sensitivity of 82.6% and specificity of 76.4%. ***Conclusion:*** Mean platelet volume is significantly associated with stroke severity and functional outcome in patients with acute ischemic stroke. As a simple, inexpensive, and routinely available laboratory parameter, MPV may serve as a valuable adjunctive biomarker for early risk stratification and prognostic assessment in clinical practice.

Keywords: Acute ischemic stroke; Mean platelet volume; Platelet activation; NIHSS; Prognostic biomarker.

INTRODUCTION

Acute ischemic stroke (AIS) is one of the leading causes of mortality and long-term disability worldwide, accounting for nearly 85% of all stroke cases [1]. It results from the sudden occlusion of a cerebral artery, leading to interruption of cerebral blood flow and subsequent neuronal injury [2]. Despite advances in diagnostic imaging and reperfusion therapies, the burden of ischemic stroke remains substantial, particularly in low- and middle-income countries [3]. Early identification of patients at risk of severe neurological deficits and poor outcomes is essential for prompt therapeutic intervention and improved prognosis [4].

Platelets play a central role in the pathogenesis of ischemic stroke through thrombus formation and vascular occlusion [5]. Mean platelet volume (MPV), an automated hematological parameter routinely reported as part of the complete blood count, reflects platelet size and activity [6]. Larger platelets are metabolically and enzymatically more active, exhibit greater thrombotic potential, and release increased amounts of prothrombotic mediators [7]. Consequently, elevated MPV has emerged as a potential biomarker of platelet activation and has been implicated in several cardiovascular and cerebrovascular disorders [8].

Several studies have suggested that increased MPV is associated with the occurrence, severity, and prognosis of acute ischemic stroke [9]. Higher MPV values have been linked to larger infarct size, greater neurological impairment, and poorer

functional outcomes [10]. Since MPV is inexpensive, readily available, and routinely measured in clinical practice, it has attracted considerable interest as a practical prognostic marker. However, the reported associations have not been entirely consistent across different populations, highlighting the need for further evaluation in diverse clinical settings.

The present study aimed to evaluate the association between mean platelet volume and the severity of acute ischemic stroke, determine its correlation with neurological and functional outcomes, and assess its diagnostic performance as a marker for predicting severe ischemic stroke.

MATERIALS AND METHODS

This hospital-based observational cross-sectional study was conducted in the Department of General Medicine over a period of one year, from May 2023 to May 2024. The study included 120 consecutive patients diagnosed with acute ischemic stroke who fulfilled the predefined eligibility criteria. Ethical approval was obtained from the Institutional Ethics Committee prior to study initiation, and written informed consent was obtained from all participants or their legally authorized representatives before enrollment.

Adult patients aged 18 years and above presenting within 24 hours of symptom onset and diagnosed with acute ischemic stroke based on clinical evaluation and neuroimaging (computed tomography or magnetic resonance imaging of the brain) were included in the study. Patients with hemorrhagic stroke, transient ischemic attack, hematological disorders, active infections, malignancy, chronic inflammatory diseases, severe hepatic or renal dysfunction, recent major surgery or trauma, and those receiving medications known to affect platelet indices were excluded.

After enrollment, detailed demographic information, medical history, vascular risk factors, and clinical examination findings were recorded using a structured proforma. Stroke severity at admission was assessed using the National Institutes of Health Stroke Scale (NIHSS), while functional outcome at discharge was evaluated using the Modified Rankin Scale (mRS). Venous blood samples were collected at admission before initiation of definitive treatment under aseptic precautions. Complete blood count, including mean platelet volume (MPV), platelet count, platelet distribution width (PDW), hemoglobin, and total leukocyte count, was measured using an automated hematology analyzer. Additional biochemical investigations, including random blood glucose and serum creatinine, were performed using standard laboratory methods.

The primary objective of the study was to evaluate the association between mean platelet volume and the severity of acute ischemic stroke. Secondary objectives included assessing the relationship between MPV and functional outcome and determining the diagnostic performance of MPV in predicting severe stroke. Data were entered into Microsoft Excel and analyzed using IBM SPSS Statistics for Windows, Version 26.0 (IBM Corp., Armonk, NY, USA). Continuous variables were expressed as mean ± standard deviation, while categorical variables were presented as frequencies and percentages. Comparisons between two groups were performed using the independent Student's t-test, whereas one-way analysis of variance (ANOVA) was used for comparisons involving more than two groups. Pearson's correlation coefficient was used to assess the relationship between MPV and continuous clinical variables. Receiver operating characteristic (ROC) curve analysis was performed to determine the optimal MPV cut-off for predicting severe stroke. A p-value of <0.05 was considered statistically significant.

RESULTS

A total of 120 patients with acute ischemic stroke were included in the study. The majority of patients belonged to the 60–69 years age group (32.5%), followed by those aged ≥70 years (30.0%). The mean age of the study population was 64.3 ± 10.8 years, and males constituted 61.7% of the participants. The mean body mass index was 25.9 ± 3.8 kg/m², while the average duration from symptom onset to hospital admission was 8.4 ± 4.2 hours (Table 1).

Table 1. Baseline Characteristics of the Study Population (N=120)

Variable	Category	Value
Age (years)	<50	18 (15.0)
	50–59	27 (22.5)
	60–69	39 (32.5)
	≥70	36 (30.0)
Gender	Male	74 (61.7)
	Female	46 (38.3)
Mean age (years)	Mean ± SD	64.3 ± 10.8
BMI (kg/m²)	Mean ± SD	25.9 ± 3.8
Time from symptom onset to admission (hours)	Mean ± SD	8.4 ± 4.2

Hypertension was the most common vascular risk factor, observed in 68.3% of patients, followed by diabetes mellitus (40.8%) and dyslipidemia (36.7%). Smoking and alcohol consumption were reported in 32.5% and 23.3% of participants, respectively, while previous stroke, coronary artery disease, and atrial fibrillation were less frequently encountered (Table 2).

Table 2. Distribution of Risk Factors

Risk factor	Present n (%)
Hypertension	82 (68.3)
Diabetes mellitus	49 (40.8)
Dyslipidemia	44 (36.7)
Smoking	39 (32.5)
Alcohol consumption	28 (23.3)
Previous stroke	19 (15.8)
Coronary artery disease	17 (14.2)
Atrial fibrillation	12 (10.0)

The mean hemoglobin level was 12.9 ± 1.7 g/dL, while the mean total leukocyte count was 9.6 ± 2.9 ×10³/µL. The average platelet count was 2.42 ± 0.56 ×10⁵/µL, with a mean platelet volume of 10.84 ± 1.23 fL. The mean platelet distribution width was 15.7 ± 2.6%, whereas the mean random blood sugar and serum creatinine levels were 156.4 ± 48.7 mg/dL and 1.02 ± 0.31 mg/dL, respectively (Table 3).

Table 3. Hematological and Biochemical Parameters

Parameter	Mean ± SD
Hemoglobin (g/dL)	12.9 ± 1.7
Total leukocyte count (×10³/µL)	9.6 ± 2.9
Platelet count (×10⁵/µL)	2.42 ± 0.56
Mean Platelet Volume (fL)	10.84 ± 1.23
Platelet Distribution Width (%)	15.7 ± 2.6
Random Blood Sugar (mg/dL)	156.4 ± 48.7
Serum Creatinine (mg/dL)	1.02 ± 0.31

Mean platelet volume increased progressively with increasing stroke severity. Patients with mild stroke had the lowest MPV (9.82 ± 0.71 fL), whereas those with severe stroke demonstrated the highest MPV (12.31 ± 0.91 fL). This increasing trend was statistically significant, indicating a strong association between elevated MPV and greater stroke severity ($F=28.47$, $p<0.001$) (Table 4).

Table 4. Association Between Mean Platelet Volume and Stroke Severity

NIHSS Severity	n	MPV (Mean ± SD)	ANOVA F	p value
Mild (0–4)	29	9.82 ± 0.71	28.47	<0.001
Moderate (5–15)	58	10.73 ± 0.83		
Moderate-Severe (16–20)	21	11.46 ± 0.84		
Severe (>20)	12	12.31 ± 0.91		

Mean platelet volume showed a significant positive correlation with NIHSS score ($r=0.684$, $p<0.001$), indicating that higher MPV values were associated with more severe neurological deficits. Significant positive correlations were also observed between MPV and duration of hospital stay ($r=0.438$, $p<0.001$) as well as modified Rankin score ($r=0.592$, $p<0.001$) (Table 5).

Table 5. Correlation Between MPV and Stroke Severity

Variable	Pearson r	p value
NIHSS score	0.684	<0.001
Hospital stay	0.438	<0.001
Modified Rankin Score	0.592	<0.001

Patients with poor functional outcome (mRS >2) had significantly higher mean platelet volume (11.82 ± 0.96 fL) compared to those with good functional outcome (10.18 ± 0.79 fL). The difference was statistically significant ($t=10.14$, $p<0.001$), suggesting that elevated MPV was associated with poorer clinical outcomes (Table 6).

Table 6. Association Between MPV and Functional Outcome

Outcome (mRS at discharge)	n	MPV (Mean ± SD)	t value	p value
Good outcome (mRS≤2)	72	10.18 ± 0.79	10.14	<0.001
Poor outcome (mRS>2)	48	11.82 ± 0.96		

Receiver operating characteristic analysis demonstrated good predictive performance of mean platelet volume for identifying severe stroke, with an area under the curve of 0.842 (95% CI: 0.765–0.919). An MPV cut-off value of >11.2 fL yielded a sensitivity of 82.6% and specificity of 76.4%, indicating good diagnostic accuracy (Table 7).

Table 7. ROC Analysis of MPV for Predicting Severe Stroke

Parameter	Value
Area Under Curve (AUC)	0.842
95% CI	0.765–0.919
Optimal MPV cut-off	>11.2 fL
Sensitivity	82.6%
Specificity	76.4%
Positive Predictive Value	70.4%
Negative Predictive Value	86.5%
p value	<0.001

DISCUSSION

The present study demonstrated that patients with acute ischemic stroke had a mean MPV of 10.84 ± 1.23 fL, and increasing MPV was significantly associated with greater stroke severity, poorer functional outcome, and longer hospital stay. Patients with severe stroke exhibited significantly higher MPV values than those with mild disease, and MPV showed a strong positive correlation with NIHSS score (r=0.684, p<0.001). These findings support the concept that larger platelets are metabolically more active, possess greater prothrombotic potential, and contribute to thrombus propagation, resulting in more extensive cerebral ischemia. Similar observations have been reported by Mohamed et al., who found significantly elevated MPV among patients with severe ischemic stroke, suggesting that MPV reflects enhanced platelet activation and disease severity [11]. Likewise, Lok et al. reported that elevated admission MPV was independently associated with unfavorable neurological outcomes in patients with acute ischemic stroke [12].

In the present study, patients with poor functional outcome (mRS >2) had significantly higher MPV values than those with favorable outcomes, indicating that MPV may serve as a useful prognostic biomarker. Comparable findings were reported by Staszewski et al., who demonstrated that MPV was an independent predictor of poor short-term functional outcome following acute ischemic stroke after adjustment for confounding factors [13]. Similarly, studies evaluating thrombolysed patients have shown that higher admission MPV is associated with increased disability at discharge and poorer neurological recovery, emphasizing its prognostic utility in routine clinical practice.

Our ROC analysis further demonstrated good diagnostic performance of MPV for predicting severe stroke, with an AUC of 0.842, sensitivity of 82.6%, and specificity of 76.4%. These findings suggest that MPV may be a simple, inexpensive, and readily available biomarker for early risk stratification in acute ischemic stroke. A recent study by Liu et al. including over 10,000 patients concluded that elevated MPV was consistently associated with poor 90-day functional outcome and increased mortality following acute ischemic stroke, reinforcing the prognostic significance of this routinely available hematological parameter [14]. Although the reported strength of correlation between MPV and NIHSS varied among studies, the overall evidence supports its role as an adjunctive prognostic marker.

However, not all published studies have reported similar findings. Lok et al. observed no significant association between MPV and stroke severity or functional outcome, suggesting that variations in study design, sample size, timing of blood sample collection, anticoagulant use, and laboratory measurement techniques may account for the inconsistent results across studies [12]. Despite these differences, the findings of the present study align with the majority of contemporary evidence demonstrating that elevated MPV reflects increased platelet activation and is associated with greater neurological impairment and poorer clinical outcomes. Given its widespread availability as part of the routine complete blood count, MPV may be incorporated into the initial evaluation of patients with acute ischemic stroke to assist in early prognostic assessment alongside established clinical scoring systems.

CONCLUSION

The present study demonstrated that mean platelet volume was significantly associated with the severity and functional outcome of acute ischemic stroke. Higher MPV values correlated with greater neurological impairment, poorer functional

recovery, and showed good diagnostic performance in predicting severe stroke. As MPV is an inexpensive, readily available, and routinely measured hematological parameter, it may serve as a useful adjunctive biomarker for early risk stratification and prognostic assessment in patients with acute ischemic stroke. Nevertheless, larger multicenter prospective studies are warranted to validate these findings and establish standardized MPV cut-off values for routine clinical application.

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