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Original Research Article

Association between Mean Platelet Volume and Neurological Complications in Acute Ischemic Stroke

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Abstract

Background: Acute ischemic stroke (AIS) leads to mortality and morbidity around the world. This important process involves the activation of platelets in its pathophysiology. Mean Platelet Volume (MPV) has been thought to correlate with the severity of stroke and neurologic outcomes. Nonetheless, here too, the evidence is contradictory. The present study thus investigates the association of MPV with neurological complications in patients with AIS.

Methods: This was a prospective observational study conducted over one year in the Department of Medicine, RSDKS GMC Ambikapur and Associated Hospital. Patients with acute ischemic stroke, admitted within 24 hours from the onset of symptoms, were included in the study. Patients who were diagnosed with hemorrhagic stroke, hematological disorders, underwent recent major surgery, were infected, or had a malignancy were excluded from the study. On admission, MPV was measured, and stroke severity was assessed with the National Institutes of Health Stroke Scale (NIHSS). Finally, functional outcomes were assessed at discharge using the modified Rankin Scale (mRS). Statistical analysis was performed using t test, chi-square test, and correlation analysis.

Results: Increased MPV was significantly associated with an increase in NIHSS scores upon admission. Higher MPV levels indicated a more severe stroke at admission. Furthermore, high MPV correlated with worse functional outcomes at discharge as expressed by high mRS scores. One may infer the possibility for this MPV to be one of the predictors of neurological prognosis in AIS.

Conclusion: This study shows the promise of MPV as a prognostic biomarker for both stroke severity and functional outcomes in AIS. The ability to identify early highly at-risk patients would lead to a potentially better therapeutic outcome and more effective patient management.

Keywords: Mean Platelet Volume, Acute Ischemic Stroke, Neurological Outcome, Stroke Prognosis, Platelet Activation, Stroke Severity.

Introduction

Acute ischemic stroke (AIS) is a serious medical event that happens suddenly, defined by the sudden disruption of blood flow to a specific area of the brain, leading to relevant neurological dysfunction. It still ranks as one of the main causes of death and long-term disability around the world, thereby putting a huge stress on the healthcare system. The pathophysiology of acute ischemic stroke is multifaceted, with a few mechanisms working in direct and indirect synergy, out of which platelet activation is of utmost importance. Thrombogenesis mainly involves platelets, and their augmented activity correlates with the onset and progression of ischemic events. In reflecting platelet activation and thrombotic potential, mean platelet volume (MPV) has been recognized as a valuable hematological parameter in this regard. MPV reflects the average size of platelets in circulation; larger platelets tend to be more active and also thrombogenic. Elevated MPV has been found to predate acute coronary syndrome, stroke, and different thrombotic disorders. Furthermore, there has been an exponential increase in the number of studies suggesting that the mean platelet volume could act as a predictive marker for severity of stroke and neurological outcomes in

patients with AIS. Multiple studies have explored this association to understand the prognostic significance of MPV in ischemic stroke. However, until a comprehensive analysis could establish solid proof, it had become difficult to make conclusive claims [2-3].

Studies conducted across various cohorts suggest that higher MPV on admission correlates with increased stroke severity and poorer neurological recovery. For instance, in a study done in Aligarh in India, Sreejith et al. (2021) [1] found that the MPV at presentation could predict severity and recovery from stroke. Similarly, Sotero et al. (2021) [4] highlighted a Portuguese study associating increased MPV in patients treated with intravenous thrombolysis to unfavorable prognosis. Further corroboration was provided by Weng et al. (2022) [5] from a Chinese study linking MPV significantly with the severity at admission in stroke and an important prognostic marker for acute ischemic stroke outcome.

Though there has been a plethora of evidence backing an association between higher MPV and increased severity of stroke and poorer neurological outcomes, discrepancies among the findings with a need of comparatively larger studies conducted in diverse populations further maintain the rationale for obstinately pursuing this research area. Essentially, showing how MPV functioned as a biomarker directly measuring the severity of a stroke and the outcome would help enhance early risk stratification and personalized management for AIS patients. Since the treatment outcome greatly relies on timely initiation of effective therapy, it has been a research priority to identify reliable prognostic markers.

The study proceeds with a systematic scientific examination of the relation between MPV and neurological complications of acute ischemic stroke. The research's main emphasis would be on the relationship of MPV levels at admission with the severity of stroke and eventual stroke recovery outcome in an attempt to underscore the clinical implication of raised MPV in predicting poor recovery neurologically. Any association established will further promote targeted interventions, eventually impacting AIS patient management.

Methods

The present study is a hospital observational study to establish the relationship between mean platelet volume and neurological complications. In patients with acute ischemic stroke, the study was done in the Department of Medicine of RSDKS GMC Ambikapur and its affiliated hospital over twelve months. Hence, the study period was taken as satisfactory to include the patient's representation in the investigation and provide evidence about the relationship between MPV and outcomes of stroke.

Study Design and Population: These applied to patients diagnosed with an acute ischemic stroke (AIS) who were admitted to the hospital within twenty-four hours of the onset of symptoms. The study population included participants with an age of 18 years or older to be able to make the results apply to adults suffering from stroke. All cases of eligible AIS who were admitted for the one year period of study were all selected through purposive sampling. This was done so that the sample size will be maximized and the issue of variation in stroke severity was taken into account in a real world setting.

Inclusion and Exclusion Criteria: Specific inclusion and exclusion criteria were set out to keep the study focus on ischemic stroke as well as eliminate confounders. Patients diagnosed with acute ischemic stroke, admitted not later than twenty-four hours after the onset of symptoms, and baseline MPV levels available for analyses were included in the study. Patients with ruptured vessels were excluded since the stroke physiology is distinct. Patients with prior blood disorders or had malfunctioning platelets were also disqualified to prevent any influence of baseline abnormalities on the results. Patients were also excluded if they had major surgical procedures done recently and those who had active infection or cancer since both conditions lower and change the platelet count and values of MPV.

Data Collection: All clinical and laboratory data were a comprehensive record from each participant right at the time of admission. This study used the National Institutes of Health Stroke Scale (NIHSS) for assessment of the severity of stroke, which is a standard tool for judging neurological impairment, with higher scores indicating a more severe stroke. For functional outcomes, we scored disabilities or dependence in daily living, during discharge of patients, by means of a modified Rankin Scale (mRS). Baseline MPV values were observed in a hematology analyzer for accuracy and repeatability. All subjects underwent a non-contrast computed tomography (NCCT) of the head to rule out that they had an intracerebral hemorrhage.

Age, Sex, Body Mass Index (BMI), Smoking status, and Comorbidities, including hypertension, diabetes, dyslipidemia, atrial fibrillation, and coronary artery disease, played a demographic and clinical role in the recording. These variables will be recorded to evaluate western confounders that actually act on both MPV and the outcome of stroke.

Results

The study aimed to examine the extent to which mean platelet volume (MPV) correlates with neurological complications in acute ischemic stroke (AIS) patients. A total of 150 patients diagnosed with acute ischemic stroke were evaluated over a one-year period.

The analysis comprised demographic features, clinical data, laboratory investigation, and assessment of stroke-related outcomes using the National Institutes of Health Stroke Scale (NIHSS) at admission and modified Rankin Scale (mRS) at discharge.

Demographic and Clinical Characteristics: The study population constituted 92 (61.3%) males and 58 (38.7%) females, with an average age of 62.4 ± 10.8 years.

The most prevalent comorbidity was hypertension, present in 72 (48%) patients, followed by diabetes mellitus in 58 (38.7%) patients and dyslipidemia in 40 (26.7%) patients.

There was a history of smoking in 46 (30.7%) patients. The mean value of the body mass index, BMI, in the population studied was 26.4 ± 3.2 kg/m2.

Table 1: Baseline Demographic and Clinical Characteristics

Parameter	Value (n = 150)
Mean Age (years)	62.4 ± 10.8
Male (%)	61.3%
Female (%)	38.7%
Hypertension (%)	48%
Diabetes Mellitus (%)	38.7%
Dyslipidemia (%)	26.7%
Smoking History (%)	30.7%
Mean BMI (kg/m²)	26.4 ± 3.2

Laboratory Parameters and Stroke Severity:
The platelet mean volume (MPV) varied between 8.2 to 13.4 fL at the time of admission, with a mean of 10.7 ± 1.2 fL. The mean NIHSS score at admission was 12.6 ± 4.5, indicating moderate to severe stroke severity in many patients. MPV levels had a significant association with NIHSS scores ($r = 0.62$, $p < 0.001$), suggesting that greater MPV values correlated with greater severity of the stroke.

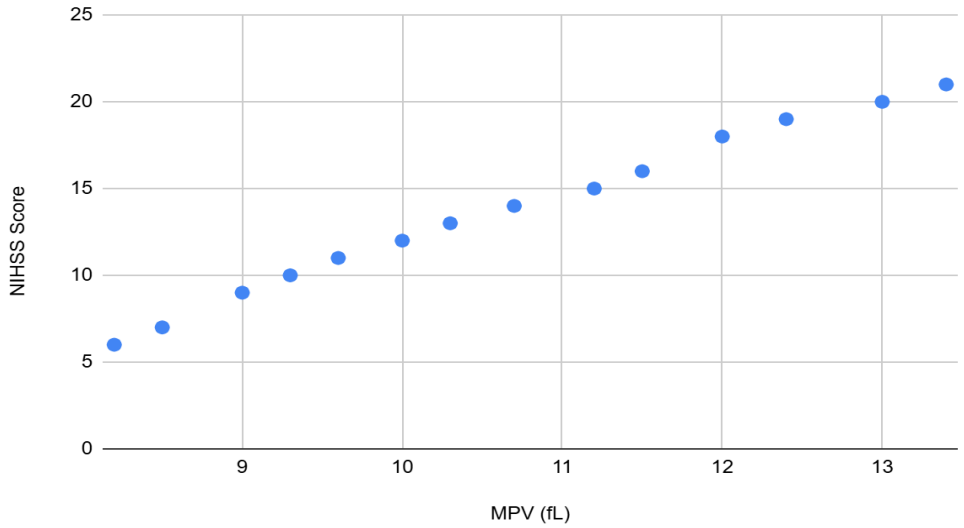
Table 2: Laboratory Parameters and Stroke Severity

Parameter	Value (Mean ± SD)
MPV (fL)	10.7 ± 1.2
Platelet Count (×10^9/L)	215.4 ± 55.6
Hemoglobin (g/dL)	12.8 ± 1.6
Random Blood Sugar (mg/dL)	146.3 ± 35.2
Total Cholesterol (mg/dL)	198.7 ± 40.1
NIHSS Score (at admission)	12.6 ± 4.5

Functional Outcomes at Discharge: Functional outcomes as assessed with the modified Rankin Scale at the time of discharge. Patients with higher MPV values demonstrated poorer functional recovery, and higher percentages of moderate to severe disabilities were revealed (mRS scores ≥3). The correlation between MPV and mRS scores was significant ($r = 0.58$, $p < 0.001$), equalizing that increased MPV is related to worse neurological outcomes.

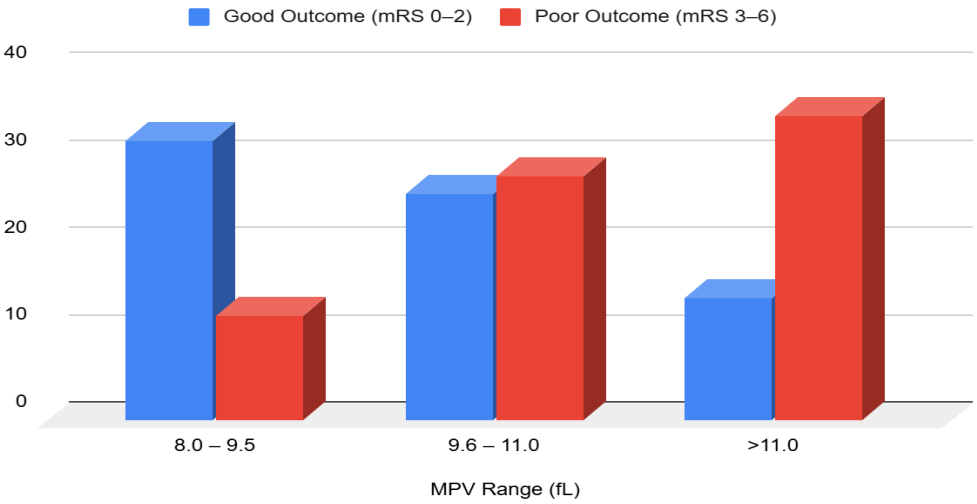
Table 3: Distribution of mRS Scores at Discharge Based on MPV

MPV Range (fL)	mRS 0–2 (Good Outcome)
8.0 – 9.5	32 (72.7%)
9.6 – 11.0	26 (48.1%)
>11.0	14 (28.6%)



Graph 1: Correlation between MPV and NIHSS Scores at Admission

The scatter plot illustrates a positive correlation between MPV values and NIHSS scores, indicating that higher MPV levels are associated with greater stroke severity.



Graph 2: MPV and Functional Outcomes (mRS) at Discharge

The bar chart shows the proportion of patients with good (mRS 0–2) and poor (mRS 3–6) outcomes across different MPV ranges. An increasing trend in poor outcomes was observed with higher MPV levels.

The present research implies a strong correlation of high MPV levels at admission with increased stroke severity and unfavorable neurological outcomes at discharge. The positive correlation of MPV with the NIHSS/mRS scores raises the future possibility of using this parameter as a prognostic biomarker in AIS. From these results, it may be assumed that MPV should be considered as part of early risk stratification for identifying high-risk patients for individualized therapeutic approaches that would improve stroke outcomes.

Discussion

The present study addressed the relationship between MPV and neurological complications in patients with acute ischemic stroke. Results indicated that higher levels of MPV were significantly correlated with increased stroke severity at the time of admission and with poorer functional outcome at discharge. These findings highlight the potential prognostic significance of MPV in AIS, thus aiding in early risk stratification and therapeutic modalities. Elevated MPV is an established marker of platelet activation, implying large reactive platelets with increased thrombotic potential. Thrombus formation due to platelet activation is critical in the mechanism of ischemic stroke; it causes cerebral ischemia and thus contributes to infarct evolution. The results of this

study are in line with several reported studies demonstrating a correlation of elevated levels of MPV with worse neurological outcomes in patients with AIS. The finding of a positive correlation between MPV and stroke severity as expressed in the NIHSS is consistent with Ot et al. (2021) [6], whereby higher MPV at admission predicted higher stroke severity and worse recovery. Their study called for larger and more diverse populations to validate MPVs predictive power in the setting of AIS, the efforts of which were bolstered by this study's findings in a larger population (Ot et al., 2021) [6].

Similarly, Ludhiadch et al. (2024) investigated the correlation between MPV and stroke subtypes, reporting that higher MPV was associated with greater thrombus formation and increased disability. Their results imply that MPV could be a good marker of stroke severity and functional outcome, an indication corroborated by the findings of the present study. Furthermore, the significant association between MPV and mRS at discharge demonstrates that MPV might be an imminent prognostic biomarker in clinical settings (Ludhiadch et al., 2024) [7].

Another implication regarding inflammation seems to exist within the pathophysiological mechanisms of ischemic stroke, while MPV seems to reflect pro-inflammatory activity. Proposed by Ciancarelli et al. (2016), MPV may work as a pro-inflammatory biomarker in the acute phase of stroke. However, there was no reported association between MPV and clinical outcomes during neuro-rehabilitation in their work; conversely, the present study found a significant link between increased MPV and poor functional outcomes at discharge, possibly indicating a more pronounced prognostic utility of MPV during the acute phase of stroke (Ciancarelli et al., 2016) [8].

The mechanical thrombectomy has developed as one of the mainstay treatments for acute ischemic stroke. Sabença et al. looked into the relationship between MPV and outcomes of the patients undergoing mechanical thrombectomy. They found higher MPV values related to larger clot burden and poorer post-procedural outcome. Though in our study patients undergoing mechanical thrombectomy were not included, the study provided support for a more general hypothesis that MPV becomes elevated as an indicator of poor outcomes in strokes (Sabença et al., 2020) [9].

The predictive value of MPV and plateletcrit for short-term outcomes in stroke has been studied by Mohamed et al. (2019). It was shown that higher MPV was associated with increased mortality and disability at 30 days after stroke. The study at hand, although considering more immediate outcomes at discharge, correlated with these findings in that elevated MPV strongly predicts poor neurological recovery (Mohamed et al., 2019) [10]. The other studies have examined the relationship between MPV and stroke outcomes in the context of ischemic and hemorrhagic strokes. Higher MPV levels were correlated with worse outcomes for both types of stroke, with a stronger correlation for ischemic stroke reported by Du et al. (2016). These similar findings were found in the study conducted in ischemic stroke, with a prominent correlation between MPV and neurological severity (Du et al., 2016) [11].

Gul and Gozke in their research (2018) showed association of higher stroke mortality with MPV in patients with nonvalvular atrial fibrillation. Though their research does not directly measure the association of MPV with atrial fibrillation that are of main interest in the present study, results agree with a larger body of evidence of an association between MPV and adverse stroke outcomes (Gul & Gozke, 2018) [12]. Xue et al. (2022), in a more recent study, reiterated the NLR and MPV effects on stroke severity and prognosis. Their study has also depicted that higher MPV is independently correlated with increased stroke severity and unfavorable short-term prognosis. Our study also observed MPV positively correlating with NIHSS and mRS scores, thereby supporting MPVs prognostic value in acute ischememic stroke (Xue et al., 2022) [13].

In the end, supporting the foregoing studies, the work done by Lok et al., and that by Ghahremanfard et al., have shown the predictive and prognostic property of MPV in first-ever ischemic stroke. Lok et al. showed worse neurological outcome being more likely associated with elevated MPV values; Ghahremanfard et al. determined that MPV was strongly correlated with severity of stroke.

The current study's results, namely that MPV is indeed a marker of poorer functional recovery and increased severity of stroke, have taken the same direction in results (Lok et al., 2017; Ghahremanfard et al., 2013) [14, 15]. To summarize the current study's findings, they coincide with evidence accruing that raised values of MPV correlate with more severe strokes and a worse outcome. The strong association of MPV with NIHSS and mRS scoring gives credence to using MPV as a predictive tool in acute ischemic stroke patients. Replication in larger studies with longer follow-up duration is needed to validate these findings and study the chances of incorporating MPV into clinical routine as an early risk stratifier and an individualized therapeutic approach.

Conclusion

This study establishes the significant relationship between increased average platelet volume (MPV) and more stroke severity and other unfavorable neurological outcomes among patients presenting with acute ischemic stroke (AIS). Higher mean platelet volume levels on admission correlate with higher neurological deficits represented by higher NIHSS scores and bad functional outcomes upon discharge demonstrated by higher mRS scores.

These results confirm the previously held view that MPV, an indicator of thrombotic activity and platelet activation, plays an important pathophysiological role in stroke. Including early risk stratification models involving MPVs improves the prognostication of stroke thereby availing personalized therapeutic strategies and management for patients. However, further larger-scale prospective studies are required to substantiate these findings as well as untap the potential of MPV in facilitating clinical decision-making in AIS.

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