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Comparison of the Mean Platelet Volume Across Various Grades of Severity of Ischemic Stroke

Arshdeep Singh[1], Surinder Kumar Salwan[1], Gagandeep Singh[1], Kanika Kohli[1], Kanwar Partap Singh Muhar[1]

[1]Department of Medicine, Sri Guru Ram Das Institute of Medical Sciences and Research, Vallah, Amritsar, Punjab, India

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Corresponding Author:

Arshdeep Singh
Department of Medicine, Sri Guru Ram Das Institute of Medical Sciences and Research, Vallah, Amritsar, Punjab, India

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ABSTRACT

Background: Acute ischemic stroke is a major cause of mortality and long-term disability worldwide. Early identification of patients at risk of severe stroke is important for timely management and prognostic assessment. Mean platelet volume (MPV), a routinely available hematological parameter, reflects platelet size and activity and may serve as a useful biomarker in ischemic stroke. **Objective:** To compare mean platelet volume across various grades of ischemic stroke severity and evaluate its association with functional outcome. **Methods:** This prospective observational study was conducted in the Department of Medicine, Sri Guru Ram Das Institute of Medical Sciences and Research, Vallah, Amritsar, over a period of 18 months from July 2024 to December 2025. A total of 75 adult patients with clinically and radiologically confirmed acute ischemic stroke were included. Stroke severity was assessed using the Modified Rankin Scale (mRS). Mean platelet volume was measured at admission using an automated hematology analyzer. Statistical analysis was performed using appropriate descriptive and inferential tests. **Results:** The mean age of the study population was 64.68±13.69 years, with male predominance (60%). Hypertension (61.3%) and diabetes mellitus (40.0%) were the most common risk factors. The overall mean MPV was 11.75±1.30 fL. Mean MPV increased progressively with increasing stroke severity, from 10.62 fL in mRS grade 1 to 12.35 fL in mRS grade 5. The difference in MPV across severity grades was statistically significant ($p<0.001$). A significant positive correlation was observed between MPV and mRS score ($r=0.406$, $p<0.001$). **Conclusion:** Elevated mean platelet volume is significantly associated with greater severity of acute ischemic stroke. MPV is an inexpensive and easily available laboratory marker that may be useful for early risk stratification and prognostic assessment in ischemic stroke patients.

Keywords*: Mean platelet volume, ischemic stroke, Modified Rankin Scale, platelet activation, biomarker, prognosis.*

INTRODUCTION

Stroke is one of the leading causes of death and long-term disability worldwide and continues to place a major burden on healthcare systems and society.[1,2] Among all stroke types, acute ischemic stroke is the most common, accounting for nearly 80–85% of cases. It occurs when blood flow to a part of the brain is suddenly blocked, leading to loss of oxygen supply, brain cell injury, and permanent neurological damage if treatment is delayed.[2] Although advances such as thrombolysis and mechanical thrombectomy have improved outcomes, many patients still experience significant disability or death. Therefore, identifying simple and reliable markers that can help predict stroke severity at an early stage is of great clinical importance.[10]

Platelets have an important role in the development of ischemic stroke. When a blood vessel wall is damaged or an atherosclerotic plaque ruptures, platelets become activated, adhere to the injured surface, and aggregate to form a clot that may block cerebral circulation.[6,7] In addition to clot formation, activated platelets release inflammatory and vasoactive

substances that can worsen vascular injury and increase the extent of brain ischemia. For this reason, platelet activity is increasingly recognized as an important factor not only in the occurrence of stroke but also in its severity and prognosis.
Mean platelet volume (MPV) is a routinely reported parameter in complete blood count testing and reflects the average size of circulating platelets.[7] Larger platelets are generally younger, more reactive, and metabolically more active. They contain denser granules, produce greater amounts of thromboxane A2, and have higher thrombotic potential than smaller platelets. As a result, elevated MPV has been linked with several cardiovascular and thrombotic conditions such as myocardial infarction, diabetes mellitus, peripheral vascular disease, and cerebrovascular disease.[12]

In recent years, MPV has received attention as a possible biomarker in acute ischemic stroke. Several studies have shown that MPV levels are significantly higher in stroke patients compared with healthy individuals, suggesting increased platelet activation in these patients.[3-5] Ghahremanfard et al.[3] reported that MPV was significantly higher in severe stroke than in mild stroke cases. Mayda-Domaç et al.[4] also found that higher MPV was associated with poorer prognosis. Furthermore, a systematic review and meta-analysis by Sadeghi et al.[5] confirmed that MPV values are significantly elevated in patients with acute stroke.

However, the relationship between MPV and stroke severity has not been completely consistent across all studies. Variations in patient characteristics, timing of sample collection, stroke subtype, associated illnesses, and laboratory methods may explain these differences.

Since MPV is inexpensive, widely available, and quickly obtained from routine blood testing, it may be a practical marker in the early assessment of stroke patients. If its association with severity is confirmed, MPV could help clinicians identify high-risk patients who need closer monitoring and timely intervention.
Therefore, the present study was conducted to compare mean platelet volume across different grades of ischemic stroke severity and to assess its association with functional outcome using the Modified Rankin Scale (mRS).

MATERIALS & METHODS

Study Design and Setting

Prospective observational study conducted in the Department of Medicine, Sri Guru Ram Das Institute of Medical Sciences and Research, Vallah, Amritsar.

Study Duration

July 2024 to December 2025.

Study Population

Seventy-five adult patients with acute ischemic stroke confirmed clinically and radiologically.

Inclusion Criteria

- Age >18 years
- Acute ischemic stroke presenting within 7 days of onset

Exclusion Criteria

- Hemorrhagic stroke
- Thrombocytopenia
- Chronic liver disease / chronic kidney disease
- Previous stroke
- Drugs affecting platelet indices

Methodology

Detailed history, examination, risk factor profiling, and laboratory evaluation were performed. Venous blood was collected in EDTA tubes and MPV measured using Sysmex XN-1000 analyzer. Stroke severity was graded using Modified Rankin Scale.

Statistical Analysis Data analyzed using SPSS. Continuous variables expressed as mean±SD and categorical variables as frequency (%). ANOVA and Pearson correlation were used. $p<0.05$ considered significant.

Ethical Approval: This study was approved by the Institutional Ethics Committee of Sri Guru Ram Das Institute of Medical Sciences and Research, Sri Amritsar (Ref. No.: SGRD/IEC/2024-360, dated 03-06-2024). The study was conducted in accordance with ethical standards and institutional guidelines.

RESULT

A total of 75 patients with acute ischemic stroke were enrolled in the present study. The demographic and clinical profile demonstrated that ischemic stroke was predominantly a disease of older adults, with a higher frequency among males.

Age and Gender Distribution

The mean age of the study population was 64.68±13.69 years. Maximum patients belonged to the 61–70 years age group (32.0%), followed by >70 years (29.3%). Patients aged 51–60 years constituted 24.0% of cases, while younger patients ≤40 years represented only 6.7% of the cohort. Male predominance was observed, with 45 (60.0%) males and 30 (40.0%) females (Table 1).

Table 1: Demographic characteristics of study population (n=75)

Variable	Category	Frequency	Percentage
Age group	≤40 years	5	6.7
	41–50 years	6	8.0
	51–60 years	18	24.0
	61–70 years	24	32.0
	>70 years	22	29.3
Gender	Male	45	60.0
	Female	30	40.0

Risk Factor Profile

Among vascular risk factors, hypertension was the most common comorbidity present in 46 (61.3%) patients, followed by diabetes mellitus in 30 (40.0%). Alcohol consumption was reported in 26 (34.7%) patients, dyslipidemia in 21 (28.0%), and smoking in 3 (4.0%) patients (Table 2).

Table 2: Distribution of vascular risk factors (n=75)

Risk Factor	Present n (%)
Hypertension	46 (61.3)
Diabetes mellitus	30 (40.0)
Alcoholism	26 (34.7)
Dyslipidemia	21 (28.0)
Smoking	3 (4.0)

Mean Platelet Volume Distribution

The overall mean MPV of the study population was 11.75±1.30 fL, with values ranging from 8.8 to 15.3 fL. Most patients had MPV values between 11.0–11.9 fL and 12.0–12.9 fL, each accounting for 26.7% of the cohort. Elevated MPV values ≥14.0 fL were observed in 4.0% of patients (Table 3).

Table 3: Distribution of mean platelet volume (MPV) (n=75)

MPV Range (fL)	Frequency	Percentage
8.0–9.9	5	6.7
10.0–10.9	16	21.3
11.0–11.9	20	26.7
12.0–12.9	20	26.7
13.0–13.9	11	14.7
≥14.0	3	4.0

Stroke Severity Assessment

Stroke severity was assessed using the Modified Rankin Scale (mRS). The majority of patients had moderate to severe disability, with mRS grade 4 being the most common (36.0%), followed by grade 5 (26.7%) and grade 3 (20.0%). Mild disability (mRS 1–2) was observed in 17.4% of patients (Table 4).

Table 4: Distribution of stroke severity by Modified Rankin Scale (n=75)

mRS Grade	Frequency	Percentage
1	5	6.7
2	8	10.7
3	15	20.0
4	27	36.0
5	20	26.7

Comparison of MPV Across Stroke Severity Grades
A progressive rise in mean MPV was noted with increasing stroke severity. Mean MPV increased from 10.62 fL in patients with mRS grade 1 to 12.35 fL in patients with mRS grade 5. Analysis of variance demonstrated a statistically significant difference in MPV across severity grades ($p<0.001$), indicating that higher MPV values were associated with more severe stroke-related disability (Table 5).

Table 5: Comparison of MPV across mRS grades

mRS Grade	Mean MPV (fL)	SD
1	10.62	1.61
2	11.09	0.97
3	11.31	0.92
4	11.94	1.34
5	12.35	1.23
p-value	**<0.001**	

Correlation Analysis
Pearson correlation analysis revealed a significant positive correlation between MPV and mRS score ($r=0.406$, $p<0.001$). This suggests that increasing MPV was moderately associated with worsening functional disability following ischemic stroke (Table 6).

Table 6: Correlation between MPV and stroke severity

Variables	Correlation coefficient (r)	p-value
MPV vs mRS score	0.406	<0.001

DISCUSSION
The present prospective observational study was conducted to evaluate the association between mean platelet volume (MPV) and severity of acute ischemic stroke. The major finding of this study was that MPV increased significantly with worsening stroke severity as assessed by the Modified Rankin Scale (mRS). Patients with severe neurological disability had higher MPV values compared with those having milder stroke, and a significant positive correlation was observed between MPV and mRS score ($r=0.406$, $p<0.001$). These findings indicate that platelet activation may play an important role in the pathogenesis and clinical progression of ischemic stroke.[3-5]

Demographic Characteristics
The mean age of the study population was 64.68±13.69 years, with most patients being above 60 years of age. The largest proportion of patients belonged to the 61–70 years age group, followed by those aged more than 70 years. This finding is consistent with the global epidemiology of stroke, where increasing age is a major non-modifiable risk factor.[1,2] Aging is associated with progressive atherosclerosis, reduced vascular elasticity, endothelial dysfunction, and accumulation of cardiovascular comorbidities, all of which contribute to increased stroke risk.

Similar age distributions have been reported by Feigin et al.[2] and other large epidemiological studies. Stroke incidence rises sharply after the sixth decade of life, making elderly individuals particularly vulnerable.

Male predominance was observed in the present study, with males accounting for 60% of the study population. This is in agreement with previous reports showing higher stroke incidence among men, especially during middle and older age.[2] Lifestyle factors such as smoking, alcohol use, hypertension, and metabolic syndrome may partly explain this observation.

Risk Factor Profile
Hypertension was the most common vascular risk factor in the present study, present in 61.3% of patients, followed by diabetes mellitus (40.0%), alcoholism (34.7%), dyslipidemia (28.0%), and smoking (4.0%). These findings are comparable to previous studies identifying hypertension as the most significant modifiable risk factor for ischemic stroke.[2,10]
Chronic hypertension leads to endothelial injury, arterial wall thickening, carotid atherosclerosis, and cerebral small vessel disease. Diabetes mellitus further increases stroke risk through accelerated atherosclerosis, oxidative stress, platelet hyperreactivity, and impaired fibrinolysis. Dyslipidemia contributes to plaque formation and instability, predisposing patients to arterial occlusion.

These metabolic and vascular disorders may also influence MPV, as chronic inflammatory states stimulate platelet production and release of larger, more reactive platelets.[5,7]

Mean Platelet Volume in Ischemic Stroke
The mean MPV in the present study was 11.75±1.30 fL, which lies toward the upper range of normal values and supports the presence of increased platelet activation in acute ischemic stroke. MPV reflects platelet size and indirectly indicates

platelet activity. Larger platelets are metabolically more active, contain denser granules, generate greater amounts of thromboxane A2, and show increased aggregation potential.[6,7]

Our findings are supported by the meta-analysis conducted by Sadeghi et al.[5], which concluded that MPV is significantly elevated in acute stroke patients. Similarly, Greisenegger et al.[11] reported that higher MPV was associated with poorer outcomes in acute ischemic cerebrovascular events.

MPV and Stroke Severity

The most clinically relevant finding of the present study was the progressive rise in MPV with increasing stroke severity. Mean MPV increased from 10.62 fL in mRS grade 1 to 12.35 fL in mRS grade 5. Patients with severe stroke had significantly higher MPV values than those with mild stroke ($p<0.001$).

This suggests a dose-response relationship between platelet reactivity and neurological disability. Similar findings were reported by Ghahremanfard et al.[3], who demonstrated significantly higher MPV values in severe stroke patients compared with mild stroke. Mayda-Domaç et al.[4] also identified MPV as an important prognostic marker in ischemic stroke. Butterworth and Bath[14] reported that elevated MPV was associated with stroke subtype and adverse clinical outcome.

The possible explanation is that larger platelets are more thrombogenic and contribute to rapid clot propagation, increased thrombus burden, poor collateral circulation, and larger infarct size. Activated platelets also release inflammatory mediators that may worsen endothelial dysfunction and microvascular obstruction, thereby aggravating cerebral ischemia.[6,7]

Correlation with Functional Outcome

A moderate positive correlation between MPV and mRS score ($r=0.406$) was found in the present study, indicating that higher MPV levels were associated with greater functional dependence after stroke.

Although the correlation was moderate, it remains clinically meaningful because stroke outcome is influenced by multiple factors including age, infarct size, infarct location, treatment delay, associated complications, and rehabilitation support.[10] Therefore, MPV should not be considered a standalone predictor but rather an adjunctive biomarker that can complement clinical and radiological assessment.

Similar observations were made by Staszewski et al.[8], who found that admission MPV predicted unfavorable outcomes in patients treated with intravenous thrombolysis.

Clinical Implications

One of the major advantages of MPV is that it is inexpensive, rapidly available, and routinely included in complete blood count testing without additional cost. This makes it especially useful in routine clinical practice and in resource-limited healthcare settings.

Patients presenting with elevated MPV may benefit from closer neurological monitoring, aggressive control of vascular risk factors, timely therapeutic intervention, and early rehabilitation planning. Thus, MPV may serve as a practical tool for early risk stratification in acute ischemic stroke.

Strengths of the Study

The strengths of the present study include its prospective design and inclusion of consecutively admitted patients with confirmed acute ischemic stroke. Stroke severity was assessed using a standardized functional scale (mRS), and MPV was measured uniformly in all participants using an automated hematology analyzer. Both comparative and correlation analyses were performed, strengthening the reliability of findings.

Limitations

Certain limitations should be acknowledged. First, the study had a relatively small sample size and was conducted at a single center, which may limit generalizability. Second, serial MPV measurements were not performed; therefore, changes following treatment could not be assessed. Third, infarct volume, TOAST classification, carotid Doppler findings, and long-term mortality outcomes were not evaluated. Fourth, other inflammatory markers such as neutrophil-to-lymphocyte ratio and platelet distribution width were not simultaneously compared.

Future Directions

Further multicentric studies with larger sample sizes are required to validate MPV as an independent prognostic marker in ischemic stroke. Future research should include serial MPV monitoring, radiological infarct volume correlation, stroke subtype analysis, long-term outcomes, and comparison with other inflammatory biomarkers.[12,15]

Combining MPV with established clinical severity scores such as NIHSS and neuroimaging findings may improve early prediction of stroke severity and outcomes.

In summary, the present study demonstrates that elevated MPV is significantly associated with greater severity of acute ischemic stroke. The progressive increase in MPV across disability grades and its positive correlation with mRS score suggest that platelet activation has an important role in stroke severity. Since MPV is inexpensive, easily available, and rapidly measurable, it may be a useful adjunctive biomarker in the routine management of ischemic stroke patients.[5,11,15]

CONCLUSION

The present study demonstrates a significant association between mean platelet volume (MPV) and severity of acute ischemic stroke. MPV values increased progressively with worsening Modified Rankin Scale (mRS) grades, and a positive correlation was observed between MPV and functional disability. These findings suggest that elevated MPV reflects increased platelet activation and may be linked to more severe neurological impairment in ischemic stroke patients.

As MPV is an inexpensive, rapid, and routinely available laboratory parameter, it may serve as a useful adjunctive biomarker for early risk stratification and prognostic assessment in acute ischemic stroke. Incorporating MPV into routine clinical evaluation may help identify high-risk patients who require closer monitoring and timely intervention.

However, larger multicenter studies are needed to further validate its prognostic utility and establish its role in standard stroke management protocols.

Declaration by Authors

Ethical Approval: Approved by the Institutional Ethics Committee of Sri Guru Ram Das Institute of Medical Sciences and Research, Vallah, Amritsar.

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Conflict of Interest: The authors declare no conflict of interest.

REFERENCES

1. World Health Organization. Global Health Estimates 2023: The top causes of death and disability worldwide. Geneva: World Health Organization; 2023.
2. Feigin VL, Brainin M, Norrving B, et al. World Stroke Organization (WSO): Global Stroke Fact Sheet 2022. Int J Stroke. 2022;17(1):18-29. doi:10.1177/17474930211065917
3. Ghahremanfard F, Asghari N, Ghorbani R, Samaei A, Ghomi H, Tamadon M. The relationship between mean platelet volume and severity of acute ischemic brain stroke. Neurosciences (Riyadh). 2013;18(2):147-151.
4. Mayda-Domaç F, Misirli H, Yilmaz M. Prognostic role of mean platelet volume and platelet count in ischemic and hemorrhagic stroke. J Stroke Cerebrovasc Dis. 2010;19(1):66-72. doi:10.1016/j.jstrokecerebrovasdis.2009.03.003
5. Sadeghi F, Kovács S, Zsóri KS, Csiki Z, Bereczky Z, Shemirani AH. Platelet count and mean volume in acute stroke: a systematic review and meta-analysis. Platelets. 2020;31(6):731-739. doi:10.1080/09537104.2019.1680826
6. Nurden P, Bihour C, Smith M, Raymond JM, Nurden AT. Platelet activation and thrombosis: studies in a patient with essential thrombocythemia. Am J Hematol. 1996;51(1):79-84. doi:10.1002/(SICI)1096-8652(199601)51:1<79::AID-AJH13>3.0.CO;2-6
7. Bath PM, Butterworth RJ. Platelet size: measurement, physiology and vascular disease. Blood Coagul Fibrinolysis. 1996;7(2):157-161.
8. Staszewski J, Pogoda A, Data K, et al. The mean platelet volume on admission predicts unfavorable stroke outcomes in patients treated with IV thrombolysis. Clin Interv Aging. 2019;14:493-503. Published 2019 Feb 27. doi:10.2147/CIA.S195451
9. Botezat MM, Caragea AG, Popescu G, Roşu GC, Zorilă MV, Ţenea-Cojan TŞ. Outcome in acute ischemic stroke patients treated with intravenous thrombolysis - a retrospective and statistical analysis of five years' experience. Rom J Morphol Embryol. 2024 Jul-Sep;65(3):449-455. doi: 10.47162/RJME.65.3.07. PMID: 39529338; PMCID: PMC11657329.
10. American Heart Association / American Stroke Association. Guidelines for the early management of patients with acute ischemic stroke. Stroke. 2019;50:e344-e418.
11. Greisenegger S, Endler G, Hsieh K, Tentschert S, Mannhalter C, Lalouschek W. Is elevated mean platelet volume associated with a worse outcome in patients with acute ischemic cerebrovascular events?. Stroke. 2004;35(7):1688-1691. doi:10.1161/01.STR.0000130512.81212.a2
12. Chu SG, Becker RC, Berger PB, et al. Mean platelet volume as a predictor of cardiovascular risk: a systematic review and meta-analysis. J Thromb Haemost. 2010;8(1):148-156. doi:10.1111/j.1538-7836.2009.03584.x

13. Muscari A, Puddu GM, Cenni A, et al. Mean platelet volume (MPV) increase during acute non-lacunar ischemic strokes. Thromb Res. 2009;123(4):587-591. doi:10.1016/j.thromres.2008.03.025
14. Butterworth RJ, Bath PM. The relationship between mean platelet volume, stroke subtype and clinical outcome. Platelets. 1998;9(6):359-364. doi:10.1080/09537109876429
15. Xue W, Li Y, Xia H, Yu T, Sun S, Zhang M. Influence of neutrophil-to-lymphocyte ratio and mean platelet volume on severity and short-term prognosis of acute ischemic stroke. Am J Transl Res. 2022 Jun 15;14(6):4066-4073. PMID: 35836843; PMCID: PMC9274605.