Association of Mean Platelet Volume and Red Cell Distribution Width in Acute Ischemic Stroke

Vaibhav Malve[1], Bharat Umakant Patil[2], Samir Yelwatkar[1], Darshan Rakhecha[1], Raju Gore[3], Mohan Pethe[4]

[1]Department of General Medicine, Mahatma Gandhi Institute of Medical Sciences, Wardha, Maharashtra, India, [2]Department of Pathology, Mahatma Gandhi Institute of Medical Sciences, Wardha, Maharashtra, India, [3]Department of General Surgery, SVN Government Medical College, Yavatmal, Maharashtra, India, [4]Department of Pharmacology, Mahatma Gandhi Institute of Medical Sciences, Wardha, Maharashtra, India

Abstract

Background: There is no surrogate biological marker for detecting stroke. Because of this, mean platelet volume (MPV) and RDW may be used to predict the occurrence of stroke. **Aim:** This study aims to see if there is a link between platelet volume and acute ischemic stroke, as well as between red cell distribution width and acute ischemic stroke. **Setting and Design:** This was a cross-sectional study from February 2021 to January 2023. **Materials and Methods:** The present cross-sectional study was conducted to assess the role of mean platelet volume and red cell distribution width in acute ischemic stroke. **Statistical Analysis:** For the analysis, SPSS version 20 was utilized. **Results:** A total of 300 patients were included in this study. The small vessel infarct (9.05 ± 1.24 fL) had less MPV than the large vessel infarct (9.10 ± 1.10 fL), but there was no statistically significant difference between the two (P = 0.74). The average red blood cell width was lower in minor stroke infarcts (15.06% ±2.01%) than in large stroke infarcts (15.5% ±7.26%), but no statistically significant difference was found in the study. Fifty-three (17.67%) patients had a deadly outcome, and 247 (82.33%) had been cured when a final diagnosis was made. **Conclusions:** Stroke is the world's leading cause of mortality, caused by cerebral vascular blockage or hemorrhage. However, there is no biological substitute marker for stroke diagnosis. RDW and MPV are potential biomarkers for this function and can forecast the incidence of stroke.

Keywords: Acute ischemic stroke, mean platelet volume, red cell distribution width

Introduction

Acute stroke may be detected or predicted by variations in platelet volume and count (mean platelet volume [MPV]). In contrast to MPV, a measurement of platelet size, which is a marker of platelet function, thromboxane A2 aggregation and release, platelet factor, and beta-thromboglobulin are all indicators of platelet activity.[1] Big platelets exhibit better aggregation to adenosine diphosphate, collagen, or adrenaline due to their increased granule content, and they also create more thromboxane A22 than platelets of normal size (TxA2).[2] Reports claim that platelets are essential for atherothrombosis and ischemic stroke growth. A platelet turnover metric is known as MPV.[1] Larger and immature platelets often have more granules, causing them to release more chemokines, promoting more platelet aggregation and activation. When the MPV and platelet count are elevated simultaneously, the risk of thrombosis rises.[3] It has been noted that people with risk factors such as diabetes, hypercholesterolemia, metabolic syndrome, and renal artery stenosis had larger platelets. In earlier research, MPV levels were above average for patients with acute stroke, myocardial infarction (MI), chronic vascular disease, or vascular risk factors.[4]

In addition, some data indicate that elevated MPV is linked to poor outcomes for MI and stroke survivors and a higher risk of restenosis after coronary angioplasty.[5] Red blood cell (RBC) Red cell distribution width (RDW) measures the RBC volume variability. The RBC volume variation coefficient is more objective and dependable than the blood smear variation coefficient.[6] In the general population, RDW ranges from

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Address for correspondence: Dr. Samir Yelwatkar, Department of General Medicine, Mahatma Gandhi Institute of Medical Sciences, Sevagram, Wardha - 442 102, Maharashtra, India.
E-mail: samiryelwatkar@mgims.ac.in

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11.0% to 16.0%. RDW will rise under specific physiological and pathological circumstances.[7]

At least five clinically significant elements of RDW exist. The first step is identifying and deciding how to treat iron deficiency anemia. The magnitude of RDW can be used to distinguish between folate deficit and iron deficiency anemia.[8] Because certain hemophilia releases immature RBCs into the bloodstream, RDW will increase.[9] The mean corpuscular volume (MCV), a potential indicator of impending iron deficiency, falls in iron deficiency anemia before the RDW rises. When MCV is low, RDW will sharply increase. RDW will rise in response to iron therapy before eventually returning to normal.[10] Recognizing small cells and poor pigment anemia is the next stage. The classification of anemia is the last step. Several studies have discovered a substantial correlation between RDW and mortality and cardiovascular events, such as acute coronary syndrome, ischemic cerebrovascular disease, peripheral artery disease, heart failure, atrial fibrillation, and hypertension.[11] This is the fourth clinically significant area. Sixth, RDW may predict death in those with cancer, chronic lung disease, or acute renal failure.[12] Stroke, caused by a blockage or hemorrhage of a cerebral artery, is the leading cause of mortality globally.[13]

Neurological information, neurological imaging, and patient history are used in medical diagnosis. The Glasgow Coma Scale, the Canadian Neurological Scale, the Scandinavian Stroke Scale, and the National Institutes of Health Stroke Scale are a few of the scoring systems used to assess the severity of a stroke.[14] Biological surrogate markers do not exist to identify stroke, however. For this reason, alternative measures that can anticipate the incidence of stroke include MPV and RDW. This study covered patients over 18 with their first acute ischemic stroke.[15] This study investigates the potential associations between acute ischemic stroke and red cell distribution width and platelet volume. However, there is no surrogate biological marker for detecting stroke. Because of this, MPV and RDW may be used to predict the occurrence of stroke. Therefore, this study aims to see if there is a link between platelet volume and acute ischemic stroke, as well as between red cell distribution width and acute ischemic stroke.

Materials and Methods

The current cross-sectional study was conducted at a tertiary care hospital in rural Maharashtra from February 2021 to January 2023. For this study, 300 patients with their first acute ischemic stroke were chosen and were diagnosed with the help of computed tomography. Patients having only the first event of acute ischemic stroke and aged more than 18 years were included. Patients with peripheral vascular disease, acute infections, high C-reactive protein levels, inflammatory conditions, acute MI, cancer, cranial trauma, intracranial hemorrhage, hematomas, or any other disease that affects the levels of either the MPV or red cell distribution width; pregnant patients without valid written informed consent; and patients taking discharge against medical advice were excluded. Examining the relationship between MPV and red cell distribution width in acute ischemic stroke is the major objective of this study.

Two milliliters of venous blood was obtained from each patient in ethylenediaminetetraacetic acid (EDTA)-containing sterile tubes, and the blood samples were sent to the hospital's hematology laboratory. To reduce the potential influence of EDTA on the MPV, complete blood counts, platelet indices (MPV and platelet distribution width [PDW]), and RBC indices (red cell distribution width [RDW] and RBC count) were assessed within 60 min using an automated hematology analyzer (Beckman Coulter, DxH 560 AL, serial number BE070219). In order to offer visual confirmation of the automated outcomes, peripheral blood smear examinations were also performed. To eliminate systemic inconsistency, all blood samples were examined daily in the same laboratory of our tertiary care teaching hospital.

Appropriate statistical tests of significance shall be applied depending on whether the data are parametric or nonparametric. The parameters considered were smoking, a history of alcohol intake, hypertension, diabetes mellitus, chronic obstructive pulmonary disease (COPD), chronic liver disease (CLD), chronic kidney disease (CKD), drug history, family history, and electrocardiograph changes. Transcription was a step in the data analysis process, examination of preliminary data, content analysis, and interpretation. Microsoft Excel (Windows 10; version 2016) and statistical applications were used to gather the data. For the analysis, SPSS version 20 was utilized (Armonk, NY).

The Institutional Ethics Committee approved this study (MGIMS/IEC/MED/40/2021 dated January 21, 2021). Informed consent was also taken from every patient in their language regarding their willingness to participate in the study.

Results

To correlate the MPV with the subsequent research risks, we first compared gender with MPV and reported that the average platelet volume of females, 9.02 ± 1.08, was lower than that of males, 9.13 ± 1.16. Alcoholic patients had lower MPVs than smokers, with $P = 0.87$, and there was no statistically significant difference between the hypertensive and nonhypertensive groups. The smoking group had higher MPVs than the nonsmoking group [$P = 0.14$, Table 1]. Table 2 shows that a large vessel stroke infarct diagnosis was made in the majority of the cases, with 100 (33.33%) cases, followed by 74 (24.67%) cases of acute lacunar infarct, 66 (22%) cases of stroke infarct right hemiparesis, and 58 (19.3%) cases of stroke infarct left hemiparesis [Table 2]. Multiple linear regression analysis between the dependent variable (red blood cell dispersion width) and the independent variable (risk factor) in acute schematic stroke is seen in Table 3. The present study concludes from the given regression table that the dependent variable (RDW) was statistically significant with the study's

Table 1: Mean Platelet Volume and risk factor in acute ischemic stroke

Risk factor	*n*	Mean MPV	Standard Deviation	Standard Error	*P*
Gender					
Female	106	9.0257	1.08	0.1	0.41
Male	194	9.1315	1.16	0.08	
Age (years)					
<60	111	9.0923	1.06	0.1	0.66
				0.88	
>60	189	9.0953	1.18		
Smoking					
No	251	9.0516	1.15	0.07	0.14
Yes	49	9.3122	LOI	0.14	
Alcohol					
No	183	9.1	1.2136	0.0894	0.87
Yes	117	9.08	1.0136	0.0937	
Hypertensive					
No	106	9.0952	1.27 1	0.1235	0.99
Yes				0.0762	
	194	9.0936	1.0619		

Table 2: Final diagnosis of acute ischemic stroke patients

Final Diagnosis	No. of Cases	Percentages
Acute lacunar infarct	74	24.67%
Large stroke infarct	100	33.33%
Stroke infarct left hemiparesis	58	19.33%
Stroke infarct right hemiparesis	66	22.00%
NA	2	0.67%
Total	300	100.00%

NA: Not applicable

independent risk factors [$P = 0.01$, Table 4]. When the volume of the infarct was compared following the final diagnosis, the small vessel infarct (9.05 1.24 fL) had a smaller MPV than the large vessel infarct (9.10 1.10 fL), but there was no statistically significant difference between the two (P value = 0.74). The average RBC width was lower in minor stroke infarcts (15.06% ±2.01%) than in large stroke infarcts (15.5% ±7.26%), but no statistically significant difference was found in the study [Table 5]. Fifty-three (17.67%) patients had a deadly outcome, and 247 (82.33%) had been cured when a final diagnosis was made.

Discussion

One of the main factors in long-term impairment and mortality that depends on platelets is the pathophysiology of ischemic stroke. A stroke is a symptom of a focused or generalized impairment of brain functioning.[16] Even though there are several research about the evaluation of platelet indices in stroke patients, there is very little literature on studies of a similar nature in patients of various Indian ethnicities. This study was conducted to determine the significance of platelet indices (MPV and PDW) and their measurement in patients with acute ischemic stroke.

This study aimed to determine if PDW and MPV, particularly in central rural India, may contribute to the onset of an ischemic stroke.

In the present study, 194 men (64.67%) comprised the bulk of participants, compared to 106 women (35.33%). In the situations selected for this study, men predominate clearly. A study by Kamalakannan *et al*., in which 59% of participants were men and 41% were women, is comparable to the current study, in which men made up the majority of stroke patients. Of the stroke cases enrolled, men constituted a definite majority.[17] One hundred and eleven patients were above 60 years of age, and 189 were below 60 years of age. For a healthy person, smoking is directly linked to risky health issues. A smoking habit was present in 49 out of 300 cases, alcohol dependence was present in 117 instances (or 39%), diabetes mellitus history was present in 103 cases (34.33%), and hypertension was present in 194 cases (or 64.67%) of the study. Male Indians are more likely than females to have modifiable risk factors, including drinking and smoking. The Framingham Heart Study and other international prospective epidemiological studies have identified high blood pressure, diabetes mellitus, hyperlipidemia, and smoking as the primary atherogenic risk factors for stroke.[18]

Hypertension was identified as the most significant risk factor for stroke in a cross-sectional community-based case–control research in Kolkata, with odds ratios (OR) of 5.04 (95% confidence interval [CI]: 4.16–5.92) for females and 21.87 (95% CI: 18.69–25.05) for males.[19] There was no statistically significant difference between those with hypertension and those without. Comparatively to the nonsmoking group, the smoking group exhibited greater MPVs.

When a final diagnosis of acute ischemic stroke patients was assessed, it was observed that a large stroke infarct diagnosis was present in the majority of the cases, with 100 (33.33%) cases, followed by 74 (24.67%) cases of acute lacunar infarct, 66 (22%) cases of stroke infarct right hemiparesis, and 58 (19.3%) cases of stroke infarct left hemiparesis. The current study concludes that the dependent variable (RDW) is statistically significant with independent risk factors. Similarly, only 25 (88.33%) patients had a history of stroke in the family, even though most cases had no such history. Just 2 (0.67%) cases in this research had COPD, even though COPD is not present in most patients. It is unclear how exactly COPD and stroke risk are related now, but there may be connections. It is widely recognized that aging and persistent cigarette smoking, two major risk factors for COPD, are also known to increase the risk of stroke.[20] Therefore, these common risk factors may affect the relationship between COPD and stroke. Only 7 (2.33%) had CLD among the cases. Similar research was conducted by Tziomalos *et al*. on the severity and course

Table 3: Multiple linear regression analysis between dependent variable (RDW) and independent variable (Risk factor) in acute schematic stroke

Predictor	Coefficient	Estimate	Standard Error	t-statistic	*P*
Constant	ß0	17.96	4.27	4.21	0
Smoking	ß1	-0.17	0.44	-0.4	0.69
Alcohol	ß2	0.53	0.34	1.56	0.12
DM	ß3	-0.26	0.32	-0.8	0.42
HTN	ß4	-0.15	0.34	-0.44	0.66
COPD	ß5	2.25	1.86	1.21	0.23
CLD	ß6	-0.86	1.03	-0.84	0.4
CKD	ß7	-2.79	0.82	-3.41	0
Drug History	ß8	-0.01	0.37	-0.02	0.98
Family History	ß9	0.27	0.55	0.5	0.62
ECG Changes	ß10	-0.12	0.36	-0.33	0.74

DM- diabetes mellitus, HTN- hypertension, COPD- chronic obstructive pulmonary disease, CLD- chronic liver disease, CKD- chronic kidney disease, ECG- electrocardiograph

Table 4: Analysis of Variance Table

Source	d.f	SS	MS	F-statistic	*P*
Regression	10	138.39	13.84		
Residual Error	289	1756.38	6.08		
Total	299	1894.77	6.34	2.28	0.01

Table 5: Comparison of MPV (Mean platelet Volume) and RDW (Red Cell Distribution Width) with final diagnosis

	Final Diagnosis		*P*
Variable	Large Stroke Infarct	Small stroke infarct	
MPV	9.1065±1.1015	9.0578±1.2465	0.74
RDW	15.57±2.65	15.06±2.01	0.84

MPV- Mean platelet volume, RDW- red cell distribution width

of acute ischemic stroke concerning nonalcoholic fatty liver disease (NAFLD).[21] This study concluded that NAFLD did not appear connected with a worse inhospital outcome or a more severe stroke in individuals treated for acute ischemic stroke.

Eleven (3.67%) cases had CKD, unlike most people who were not suffering. CKD is a distinct risk factor for ischemic and hemorrhagic stroke. In addition, renal impairment is linked to a worse functional outcome, a higher death rate, and a bigger neurological disability after an ischemic stroke.[22] Advanced CKD (estimated glomerular filtration rate: 30 mL/min) has been linked to a greater risk of hemorrhagic transformation after acute ischemic stroke (OR: 2.90, 95% CI: 1.26–6.68, $P = 0.01$). Patients with hemorrhagic stroke who have moderate-to-severe CKD had hematoma volumes that are 2.3 times greater. These findings may be explained by the greater comorbidity profile of CKD patients who experience strokes or by the subclinical cerebral vascular disease load observed in people with renal failure.[22] When a comparison of the volume of the infarct after the final diagnosis was done, it was observed that the small vessel infarct (9.05 ± 1.24 fL) had less MPV than the larger infarct (9.10 ± 1.10 fL) but that there was no statistically significant difference between the two ($P = 0.74$).

The average RBC width was lower in minor stroke infarcts (15.06% ±2.01%) than in large stroke infarcts (15.5% ±7.26%), but no statistically significant difference was found in the study. Of the outcome of acute ischemic stroke patients among the study population, 53 (17.67%) patients had a deadly outcome, and 247 (82.33%) had been cured of the illness by the time a final diagnosis was made.

Limitations

Large-scale studies with a larger patient population are needed to establish MPV and RDW as diagnostic or ancillary tests.

Conclusions

There is no biological substitute marker for stroke diagnosis. RDW and MPV are potential candidates for this function and can forecast the incidence of stroke. According to this study, MPV is elevated during the acute stage of an ischemic stroke. Using multivariate regression analysis to account for additional significant factors, it can be argued that an increase in MPV is independently linked with stroke. These findings imply a role for bigger platelets in the development of cerebral thrombosis and probably represent thrombopoiesis-related alterations. The RDW may help predict a stroke's severity and functional outcomes when a person has had symptoms for at least 24 h. Higher RDW is a powerful predictor of mortality and the chance of experiencing an ischemic stroke, even though the biochemical causes are unknown. Additional research is required to comprehend how platelet volume affects stroke pathology, outcome, and, most critically, stroke risk factors in people.

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Conflicts of interest
There are no conflicts of interest.

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