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Original Research

Evaluating Mean Platelet Volume as an Independent Risk Factor for Stroke

Syed Farhan Uddin[1], Habib-ur-Rehman Chohan[1], Shafaq Ansari[1], Naila Noor[1], Bhawani Shankar[2], Kiran Waheed[3], Syed Ain-ul-Abdeen[4], Syeda Mahnoor[5]

[1]Department of Physiology, Muhammad Medical College, Mirpurkhas
[2]Department of Pathology, Muhammad Medical College, Mirpurkhas
[3]Departments of Biochemistry, Liaquat Institute of Medical and Health Sciences (LIMHS), Thatta
[4]Bilawal Medical Colleges, Liaquat University of Medical and Health Sciences (LUMHS), Jamshoro
[5]Department of Medicine II, Liaquat University Hospital, Hyderabad, Sindh – Pakistan

ABSTRACT

Objective: The study aimed to evaluate the effects of mean platelet volume on stroke.

Materials & Methods: A cross-sectional study was conducted at Muhammad Medical College, Mirpurkhas, Pakistan. The sample size of this study was 200 participants including 50 stroke patients and 150 controls. Participants were aged 40-80 years, with a baseline NIHSS score of ≤ 5. Blood samples (5 ml) were collected and analyzed for mean platelet volume (MPV). Blood pressure was measured manually.

Results: The results show that individuals with raised MPV have a higher incidence of stroke than individuals with normal MPV. The Chi-Square test revealed a significant association between elevated MPV and stroke incidence ($p = 0.0001$). The demographic data showed that the stroke group had a higher mean age (59.32±8.14 years) compared to the control group (52.19±12.30 years), with a significant p-value of 0.0002. Systolic and diastolic blood pressures were significantly higher in the stroke group ($p < 0.05$). MPV was significantly elevated in stroke patients (11.94±0.65 fL) compared to controls (7.90±0.83 fL), with a p-value of 0.0001.

Conclusion: There is a significant relationship between raised MPV in patients with stroke compared to the normal population.

Keywords: Stroke, Mean Platelet Volume (MPV), System XN 3000, Intracranial Hemorrhage.

Corresponding Author: Syed Farhan Uddin
Department of Physiology, Muhammad Medical College, Mirpurkhas
Email: syedf4252@gmail.com

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INTRODUCTION

Platelets are the crucial blood component that plays a role in hemostasis maintenance and initiates the process of inflammation at the injury site. Their size is measured utilizing a parameter called mean platelet volume (MPV), and its levels vary in many pathological diseases like stroke, and it can be used as a marker for their earlier. Thrombocytes, also called platelets, are a component of blood that plays a crucial role in hemostasis in the body. They perform their function by initiating the process of inflammation and fibrosis by aggrading at the site of injury and signaling other blood cells to accumulate with the help of their cytoplasmic chemoattractant that is stored in their vesicles. Their normal levels in the blood range from 150,000 to 400,000/mm.[1] Their physical properties are different in all individuals, and among their many properties, their size is the most important physical property that is used in medical research because of their size variation in many physio-pathological diseases, and it can be used to detect these early. Platelet size is measured with the help of a blood parameter called mean platelet volume (MPV), and it ranges from 5 to 10 fL in a normal individual.[2] Stroke is one of the most prevalent neurovascular diseases and is defined clinically as an acute and focal deficit after vascular injury in brain tissue. It is the second-leading cause of death and the third-leading cause of population impairment around the world.[3-4] It is estimated in the 2019 survey that around the world, up to 77.19 million individuals had an ischemic stroke, and among these, 3.3 million died due to ischemic stroke, and this level will reach 62.53 million in 2020.[5] for the last few years the relationship between MPV and stroke become an interesting topic for debate. It is seen that any platelet dysfunction or structural abnormality increases the chance of intracranial stroke or hemorrhage in a normal individual, so now many researchers are using MPV as a prognostic marker for stroke, indicating that higher levels of MPV will worsen the outcome in the individual.[6] The MPV is also found to be associated with many other pathological disorders, including metabolic syndrome, diabetes mellitus, myocardial infarction, and acute ischemic stroke. In these cases, the basic pathological phenomenon is the same: the large size of platelets and the high levels of chemoattractant that will cause platelet clumping and lead to occlusion of the body microvasculature.[7-8] Platelet size is not the only factor that plays a pivotal role in stroke prevalence, including dyslipidemia, which is one of the most important modifiable risk factors that causes 1.8 to 2.6 times more strokes in a normal, healthy person.[9-10]

The objective of this study is to see the relation between high MPV and the incidence and severity of stroke. The rationale of this study is to investigate the relationship between stroke and MPV, as stroke is a major cardiovascular risk factor and the second-leading cause of death worldwide. This also addresses the lack of regional data and improves stroke management.

MATERIAL METHODS

Study Design and Setting

This was a cross-sectional type of study that was conducted for a period of three months from January 1, 2024, to March 30, 2024. This study was approved by the ethical board of Muhammad Medical College, Mirpurkhas, Sindh, Pakistan, with Letter No. MMC.361.

Sampling Technique and Sample Size

The sample size for this study was calculated by the sample size formula to estimate a proportion. Around 340 patients visited the neurosurgery unit of the hospital, but among them, 140 patients were excluded from this study because they did not fulfill the standard criteria of this study. In the final, 200 participants were selected using a convenience sampling technique for this study.

For study purposes, they were divided into two groups: a study group of 50 participants who had strokes and a control group of 150 individuals who didn't have strokes. All participants were informed about the study objective and procedures that were used during the study, and written consent was obtained from all 200 participants.

Patient Population

The inclusion and exclusion criteria for this study were based on the criteria used in the study by Wang Y et al.[12] Participants included all patients admitted to the stroke unit of the hospital during the study period.

Inclusion Criteria

This study included participants aged between 40 and 80 years with no previous history of hemorrhagic stroke but currently experiencing a stroke, with a baseline National Institute of Health Stroke Scale (NIHSS) score of ≤ 5 at the time of hospital admission.

Exclusion Criteria

This study excludes patients with hepatic, renal, or cardiac insufficiency. Women participants who were pregnant. Patients with mental diseases, such as dementia or other mental illnesses that impede cooperation with treatment. Patients with autoimmune diseases, including autoimmune vasculitis. Patients with pseudo-strokes.

Blood Sample Collection and Analysis

Blood samples were taken from all participants, around 5 ml of deoxygenated blood from the cubital vein, and then collected in an EDTA collecting tube. Then samples were sent to the hospital lab for analysis of blood for mean platelet volume (MPV) using the hematology analyzer machine (System XN-3000, Japan).

Blood Pressure Measurement

The blood pressure of all participants was measured through a manual sphygmomanometer, keeping the reference level according to the World Health Organization (WHO) guidelines, with systolic BP > 140 mmHg and diastolic BP > 90 mmHg considered elevated. The normal range for MPV was considered to be 6.8 to 10.8 fL.

Statistical Methods

Descriptive statistics, specifically frequency distribution, and percentages, were used in statistical analysis to evaluate the relationship between MPV and stroke in the study population. For continuous demographic variables (e.g., age, sec) and categorical clinical variables (e.g., gender, smoking status), frequency distribution and percentages were used for descriptive analysis. Histograms were applied to visualize the distribution of MPV among the participants. The inferential analysis involved the use of the Chi-Square test to determine the statistical significance of the relationship between MPV levels and the occurrence of stroke. P-values were calculated using the Chi-Square test, with a p-value of less than 0.05 considered statistically significant.

RESULTS

Demographic Data of Population

A total of 150 participants were included in the control group and 50 participants were included in the study group. The age of the control group was 52.19±12.30 and that of the case group was 59.32±8.143 with a significant p value of 0.0002. The BMI of the control group was 24.35±1.362 and of the study group 24.31±1.489 with a non-significant p-value of 0.84. The mean of systolic BP of the control group was 175.1±38.78 and that of the study group was 143.9±11.73 with a

Table 1: Comparison of demographic and physical parameters between control and case group participants.

Parameters	Control Group (N=150)	Study Group (N=50)	P-Value	df	CI (95%)
Age	52.19±12.30(1.004)	59.32±8.143(1.152)	0.0002*	198	3.452 to 10.80
BMI	24.35±1.362(0.1112)	24.31±1.489(0.2127)	0.8371	197	0.4995 to 0.4051
Systolic BP	175.1±38.78(3.167)	143.9±11.73(1.659)	0.0001	198	-42.20 to -20.20
Diastolic BP	104.5±11.75(0.9598)	99.00±8.978(1.270)	0.0028*	198	-9.085 to -1.915
MPV	7.900±0.8334(0.06805)	11.94±0.6455(0.09129)	0.0001*	198	3.785 to 4.295

*significant values

a significant p-value of 0.0001. The diastolic BPs of the control group were 104.5±11.75 and 99.00±8.978 with a significant p-value of 0.0028. The MPV of the control group was 7.900±0.8334 and that of the study group 11.94±0.6455 with a significant p value of 0.0001. To determine the significance of these parameters, the unpaired t-test was used.

Age and Gender Distribution

Among the 200 participants, 100 were male and the remaining 100 were female. In the 40-50 years category, 60 male and 50 female participants were present. For 51-70 years, 30 male and 40 female participants were present; under the age group of 71-80 years, 10 male and 10 female participants were present.

Table 2: Age and Gender distribution of the participants.

Participants Age	Male	Female
40-50 years	60	50
51-70 years	30	40
71-80 years	10	10

Association Between Mean Platelet Volume (MPV) And Stroke

The chi-square test was applied to determine the relationship between these parameters. A highly significant association between mean platelet volume and stroke was observed (p = 0.0001), and the odds ratio was 0.15 which shows the incidence of stroke in the study group is 0.15 times more than control group, and like hood ratio =0.38. This suggests that this relation is statistically significant. Among the control group

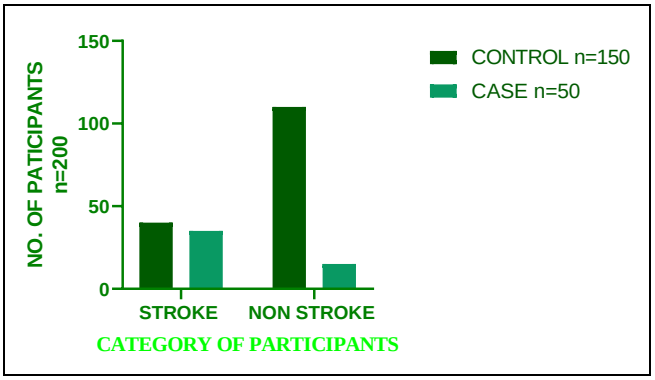

Figure 1: Comparison of MPV Levels and Stroke Incidence in Control and Case Groups.

Table 3: Comparison of Mean Platelet Volume (MPV) in Control and Case Group Participants.

Category	Control Group (n=150) MPV =7.9 fL	Case Group (n=150) MPV =11.94 fL	P-value	Odds Ratio & Likelihood Ratio	Sensitivity & Specificity
Participants with Stroke	40 (26.67%)	35 (70.00%)	0.0001 (significant value)	0.1558 & 0.3810	0.2667 & 0.3000
Participants Without Stroke	110 (73.33%)	15 (30.00%)			
TOTAL (n=200)	150	50			

participants, 40 (26.7%) had a stroke with elevated MPV, but 110 (73.3%) were normal, in contrast to the case group, 35 (70.0%) participants had a stroke with elevated MPV, while 15 (30.0%) were normal.

Comparisons

See Figure 1, which compares the MPV levels in control and case group participants. It shows that in the sample size of 200 participants, 150 participants with MPV of around 7.9 fL were placed in the control group while 50 participants with MPV of about 11.94 fL were placed in the case group. In the control group, only 26.7 % of the population had a stroke while 73.3% were normal but in contrast to it case group 70% population had a stroke along with raised MPV and only 30% of participants were normal (p-value 0.0001).

DISCUSSION

The results of this study show that individuals with high MPV, i.e., more than 10.8 fL, had a higher incidence of stroke compared to the normal population. This relation is statistically supported by a P-value of 0.0001, an odds ratio of 0.15 that shows the incidence of stroke in the study group is 0.15 times more than the control group, specificity and sensitivity of 0.3 and 0.26, and a likelihood ratio of 0.38. These study results align with other research findings. Mehmood et al, found a correlation between elevated MPV and the incidence of Stroke with a supporting P-value of 0.0005 and an odds ratio of 1.82 that shows the incidence of stroke in the study group is 1.82 times more than the control group.[12] Pamarthi et al, also sound elevated MPV in participants who had acute ischemic stroke and further support this relation by the statistical value of p-value less than 0.001 and odds ratio of 2.15 that shows the incidence of stroke in the study group is 2.15 times more than the control group.[13] Zarmehri et al. Found that ischemic strokes are less common than hemorrhagic strokes in participants with elevated MPV P-value<0.01 and odds ratio of 1.95 which shows the incidence of stroke in the study group is 1.95 times more than the control group.[14] Sreejith et al, also showed that participants with elevated MPV have the risk of ischemic stroke twice as high as a normal population with a P-value of 0.001 and odds ratio of 2.3 which shows the incidence of stroke in the study group is 2.3 times more than the control group.[15]

Choi et al, showed that the prevalence of hyperintensities of cerebral white matter was higher in people with high MPV than in the normal population (P-value 0.002 and odds ratio 1.67 that shows the incidence of stroke in the study group is 1.67 times more than in control group.[16] Mahmood et al, also show that patients with elevated blood levels of MPV are associated with a higher risk of stroke than normal participants.[17] Chaitanya et al, demonstrated during their research that high MPV was associated with the severity of the stroke, supported statistically by a P-value of 0.002, which underscores that MPV is a predictive marker of stroke.[18] Vivekanand Kamat et al, showed that patients within the scoring range of 3-6 over the Modified Rankin Scale (MRS) had a higher MOV and were also associated with severe stroke. [19] Yiqin Yao et al, and Aleksander Dbiec et al, found that higher blood levels of MPV were associated with worse outcomes after 3 months in patients with large artery atherosclerosis stroke with a P-value of 0.05.[20-21] But there is another group of researchers that oppose these results. Zheng et al, conducted a study and showed that there is no significant relation between MPV and cerebral infraction with p > 0.05.[17] Li et al, conducted a Mendelian randomization study and analysis of the platelet impact on the occurrence of ischemic stroke and showed that no obvious relationship is present with a p-value of 0.30 and

an odds ratio of 1.02.[18] Pavithran et al, used many blood parameters to predict early ischemic stroke outcomes but did not find a direct relation between high MPV and stroke prognosis with a p-value of 0.18.[19] Thus, the MPV can be used as a potential blood parameter for significant early detection of stroke and for easy detection for early treatment to prevent the worse outcome of the disease.

CONCLUSION

This study concludes that there is a significant relation between raised MPV and stroke in comparison to the normal population.

LIMITATIONS

There are certain limitations to this study. First, it was a cross-sectional study, Secondly, the sample size was small, Thirdly, this study was conducted in one hospital, so the results cannot be applied to the whole population, and Fourthly, the presence of confounding variables.

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Additional Information

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AUTHORS CONTRIBUTIONS

Sr.#	Author's Full Name	Intellectual Contribution to Paper in Terms of:
1.	Syed Farhan Uddin	1. Study design and methodology.
2.	Habib-ur-Rehman Chohan	2. Paper writing.
3.	Shafaq Ansari	3. Data collection and calculations.
4.	Naila Noor	4. Analysis of data and interpretation of results.
5.	Bhawani Shankar	5. Literature review and referencing.
6.	Kiran Waheed	6. Editing and quality insurer.
7.	Syed Zain Ul Abdeen	7. Data collection and record maintenance.
8.	Syeda Mahnoor	8. Data collection.