Mean Platelet Volume Among Diabetic and Non-Diabetic Subjects Presenting Acute Ischaemic Stroke: A Comparative Study

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Abstract—An acute ischemic stroke (AIS) is a serious issue that affects people worldwide. It is the second most common reason for people deaths and the fourth main reason for people becoming disabled all around the world. Diabetes mellitus leads to increased platelet size and reactivity thereby, leading to higher Mean Platelet Volume (MPV) which plays a key part in atherosclerosis. Thus, this study was conducted to determine whether patients with diabetes mellitus had increased MPV value which contributes as a risk factor for acute ischemic stroke in these patients. Present study was a case-control study conducted on 100 patients (50 diabetic and 50 non diabetic) admitted with AIS. In the Diabetic group the mean HbA1c level was 7.67 ± 2.07 and in nondiabetic group the mean HbA1c level was 5.47 ± 1.64. The HbA1c level was significantly higher in Diabetic group ('p' <0.0001). The mean platelet volume was 10.17 (± 1.13) in Diabetic group whereas in non-diabetic group the mean platelet volume was 8.65 (± 0.96). The mean platelet volume was higher in Diabetic group (case) as compared to non-diabetic group (control) ['p' <0.0001].

Keywords— Stroke, Mean platelet volume, Diabetes mellitus, AIS, Blood glucose, Atherothrombotic

INTRODUCTION

The second highest mortality rate worldwide can be attributed to AIS, making it the prevailing factor in chronic illnesses. Strokes are further classified as: Ischemic, which account to approximately 80% cases, and Hemorrhagic: intracerebral or subarachnoid. Acute occlusion of an intracranial vessel causes reduction in blood flow to the brain region it supplies. The most common disease process underlying AIS is atherothrombotic [1-3].Platelets are very important for stopping bleeding in our body. The average size of platelets (MPV) is a common test used in labs to measure how well platelets are working and if they are active. When platelets become more active, it can lead to problems with blood vessels. In diabetic patients, there is a strong connection between AIS and increased MPV levels. This could lead to a more severe condition with a higher chance of illness and death. Whether mean platelet volume, an accessible, efficacious, affordable blood parameter be used reliably for studying genesis or worsening of AIS in patients with diabetes mellitus (DM) [3–5].

Particularly, the patients with DM show increased platelet activity. The factors that contribute to this increased platelet activity are not clearly elucidated. To focus on physiological and biochemical mechanisms in diabetes which play vital role in raised platelet activity. The middle cerebral artery (MCA) is the most common artery involved in stroke. Four segments (M1, M2, M3, and M4) make up its structure, encompassing a considerable area of the cerebral hemisphere as well as portions of the basal ganglia and internal capsule [5,6]It has been noticed that higher Mean Platelet Volume (MPV) could mean that platelets are more active. This could be related to how serious and likely a person's stroke is. A larger MPV may indicate a worse outcome. Therefore, this study aims to examine the clinical, laboratory parameters and risk factor profile of subjects with Acute ischemic stroke as well as study MPV among subjects with AIS with type -2 diabetes mellitus.

LITERATURE REVIEW

The cause of ischemic stroke has been discovered by researchers to be the obstruction of blood vessels, which hampers blood flow to the brain.The presence of a blood vessel problem results in a blockage, obstructing the blood flow to the brain in a thrombotic event. This is often caused by conditions like atherosclerosis (narrowing of the arteries), arterial dissection (tearing of the artery wall), fibromuscular dysplasia (abnormal growth of the artery wall), or inflammation [7]. The affected blood vessel experiences a blockage when small particles from different body regions get stuck and impede blood flow. Moreover, the cause of stroke impacts both the predicted outcome and the results.Sarkar and his team [8] conducted a study on a group of healthy people who donate blood. They divided the group into two, one with 60 women and the other with 65 men. The number of platelets and the average size of platelets were measured using a machine called Advia 120, made by Bayer. The women had more platelets in their blood (252.35 ± 4125 × 109 /l) compared to the men (221.87 ± 3763 × 109 /l) (p = 0.0002) At the same time, women had a lower level of thrombopoietin at 156.50 ± 5718 pg/ml compared to men at

180.4698 pg/ml, with a significant difference (p = 0.03) There were no big differences in the average size of platelets between different groups of people, but females showed a small increase.
In this study by Mashru and others [9], they looked at a group of 204 people in each group. They used a 90 percent chance of finding a true result and a 5 percent level of importance. Diabetic patients were assigned to impaired fasting glucose, and those without diabetes were chosen and assigned to their own groups. They chose 612 patients and divided them into three groups. There were 204 patients in every group. These three groups were referred to as the DM group, non-DM group and the IFG group. We measured the level of sugar in the blood after fasting, as well as the number of platelets and the size of the platelets. The average MPV level in the group with diabetes was 9. 34 fL, in the group with impaired fasting glucose was 8. 98 fL, and in the group without diabetes was 8.63 fL. When examining the MPV values, significant disparities were identified not only between the groups themselves, but also within each respective group.Balla [10] researched the levels of MPV and platelets in 167 patients who were in the hospital for a stroke within 48 hours of experiencing symptoms. They also examined 65 other individuals who were similar in terms of age, gender, and race. The doctors determined the type of stroke through clinical and imaging tests. The control group showed a lower count of MPV in comparison to individuals with AIS. The average MPV for patients with ischemic stroke was 7.35, while for the control group it was 7.09. This difference was found to be statistically significant (2P = 0.04). Patients diagnosed with cortical stroke tend to exhibit elevated MPV levels, offering a potential explanation for this variation. After 3 months of having a stroke, the MPV level did not change in the patients who survived.

The average MPV level was 7.39 (103) fL before and 7.34 (097) fL after the 3 months. This difference was not statistically significant. Patients who displayed higher mean platelet volume (MPV) levels at the start of the study and lower platelet count (PC) levels were more likely to be deceased or unable to regain independence after 3 months, in contrast to those who achieved independence.The research revealed a correlation between having an enlarged blood clot and the probability of experiencing a poor outcome after suffering an ischemic stroke [11].

METHODOLOGY

It is strongly suggested to have a structured plan to quickly assess a stroke. It is suggested that patients who can receive thrombolytics for acute ischemic strokes should have their treatment started within 60 minutes after arriving at the hospital. When a doctor first sees a patient, they first check if the person's airway, breathing, circulation, and vital signs are okay. Some patients may have trouble breathing because of pressure in their brain. They are also at risk of inhaling something or suffocating. Sometimes, a tube may need to be put into the trachea to make sure enough oxygen and air are getting in. You should do a simple fingerstick glucose check to make sure low blood sugar is not causing any problems with your brain or nerves.

Other tests that can help diagnose a condition include an electrocardiogram (ECG), coagulation factors, electrolytes, blood urea nitrogen (BUN), blood count, creatinine (Cr), and troponin.

A. Materials & Methods

Study type: This study compares different groups of people without making any changes or interventions. It looks at different characteristics in these groups and describes them.
Experimental Setting: The research was conducted at Krishna Hospital and Medical Research Centre in Karad, Maharashtra, India.
Study duration: The study took place for 18 months, starting from October 2018 until March 2020.
Ethical committee clearance: The Ethics Committee (IEC) authorizes the research, ensuring its adherence to ethical principles, which is responsible for granting ethical clearance.
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Inclusion criteria:

a) Subjects with diagnosis of AIS documented by Computed Tomography (CT) scan or Magnetic resonance imaging (MRI).

b) All genders and age above 18 years were included in the study.

After informed and written consent (according to ICMR guidelines) total 100 patients fulfilling inclusion criteria for this study were enrolled (50 Cases and 50 Controls).

B. Investigations

All the enrolled patients were subjected to haemoglobin estimation, mean platelet volume, glycosylated haemoglobin (HbA1c), platelet count, imaging studies like MRI or CT scan of brain.

1) Pragmatic Normal values

1) American Diabetes Association (ADA) guidelines for type-2 Diabetes mellitus [8] HbA1c ≥6.5% (48 mmol/mol)

2) The normal mean platelet volume ranges between 8 fL to 10 fL.[65]

3) Complete cell count and mean platelet volume calculated by Nihon KohdenCelltac Alpha MEK-6400.
4) Glycosylated hemoglobin (HbA1c) was calculated by particle enhanced immune turbidimetric test (automatically) on EM 360 TransAsia machine.
5) CT machine used is Siemens SOMATOM Emotion eco (16-slice configuration).
6) MRI machine used is Siemens 1.5 tesla.

C. Statistical Analysis

The frequency distribution of the data was depicted through the arrangement of information in charts and tables. Mean ± standard deviation (SD) was calculated for normally distributed numerical outcomes. The statistical analysis was carried out using INSTAT version 80, a software developed in India. We looked at how things were related using Pearson's correlation. The "r" value 0.2-0.39 is considered weak, 0.40-0.59 is moderate, and 0.6-0.79 is strong. The relationship between two numbers was examined using a statistical test known as the 't' test or z-test. If the p-value is less than 0.05, it means that the results are considered statistically significant.

RESULTS

In diabetes mellitus group it was observed that out of all the subjects in the study, 58% were men and 42% were women. In non-diabetic group, 56% study subjects were males while 44% were females. In Diabetic group the male to female ratio was 1:0.72, whereas the male to female ratio in non-diabetic group was 1:0.78 (Figure 1). According to the study's findings, the individuals in the diabetic group had an average age of 62.2 years, with a standard deviation of 11.20. The study's subjects who were in the non-diabetic group consisted of 38% individuals aged over 65, along with 32% falling into the age bracket of 56 to 65 years (Figure 2).

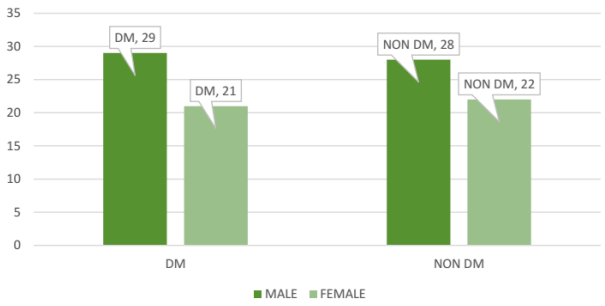

Fig. 1. Gender distribution of the study subjects

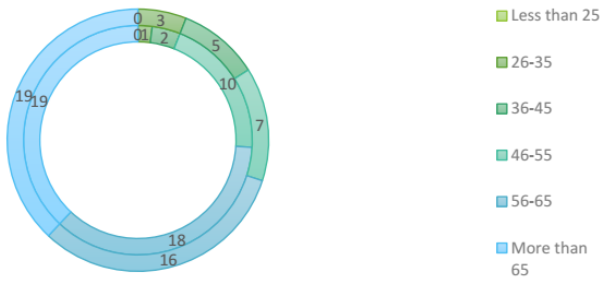

Fig. 2. Age distribution of the study subjects

In present study the personal habits of the study subjects were observed. It was seen that in Diabetic group, 34% of the study subjects had a habit of alcohol intake, followed by 24% of the subjects were smokers and 18% of the study subject were tobacco users. Dyslipidaemia was observed among 44% of the study subjects and 76% of the people being studied had high blood pressure. In the group of people who don't have diabetes, 32% of them drank alcohol, 26% of the subjects were smokers and 14% of the subjects were tobacco users. Dyslipidaemia was observed among 48% of the subjects whereas hypertension was seen among 82% of the study subjects.

TABLE I. PERSONAL HABITS DISTRIBUTION OF THE STUDY SUBJECTS

Habits	**Non-DM**		**DM**	
	Number	***%***	***Number***	***%***
HTN	41	82	38	76

Dyslipidemia	24	48	22	44
Smoker	13	26	12	24
Tobacco user	7	14	9	18
Alcoholism	16	32	17	34

Further, it was observed that in the diabetic group the mean HbA1c levels were 7.67±2.07 and in non-diabetic group the mean HbA1c levels were 5.47±1.64. It was detected that the mean HbA1c levels in diabetic group were significantly higher as compared to non-diabetic group. (T-value: 9.739, p-value: <0.0001).

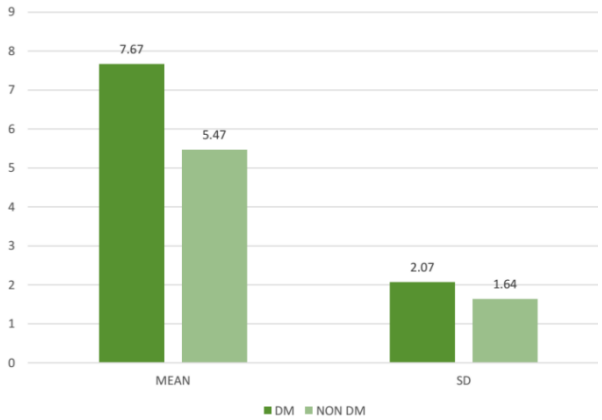

Fig. 3. HbA1c distribution of the study subjects

In Diabetic group, the mean total cholesterol levels were 164.32, triglyceride levels were 129.3, mean HDL level was 48.02, mean LDL level was 87.92. In non-diabetic group, the mean total cholesterol levels were 147.76, the mean triglyceride levels were 111.56, mean HDL level was 44.98 and the mean LDL level was 79.38.

Furthermore, it was noticed that in the group of people with diabetes, the average MPV was 10.17 ± 11.3, whereas in the group of people without diabetes, the average MPV was 8.65 ± 0.96. The analysis showed that the average size of platelets was different between the group of people with diabetes and the group without diabetes. This difference was determined to be important using student's T test. The T-value for this analysis was 15.22. The p-value is less than 0.00001 The outcome is important, with a value less than 0.05.

In Diabetic group, the mean total cholesterol levels were 164.32, triglyceride levels were 129.3, mean HDL level was 48.02, mean LDL level was 87.92. In non-diabetic group, the mean total cholesterol levels were 147.76, the mean triglyceride levels were 111.56, mean HDL level was 44.98 and the mean LDL level was 79.38.

TABLE II. LIPID PROFILE PARAMETERS

Lipid profile	**Non-DM**		**DM**		**Significance**
	Mean	***SD***	***Mean***	***SD***	
LDL	79.38	46.46	87.92	44.81	p-value: 0.25, T-value: 1.14
TG	111.56	29.27	129.3	34.66	p-value: 0.28 T-value: 1.07
TC	147.76	47.62	164.32	51.91	p-value: 0.05 T-value: 1.97
HDL	44.98	9.93	48.02	10.47	p-value: 0.2, T-value: 1.29

TABLE III. COMPARISON OF DISTRIBUTION OF VARIOUS PARAMETERS IN STUDY GROUP

Variables	**Non-DM (Mean ± SD)**	**DM (Mean ± SD)**	**P-value**

Age	62.84 ± 10.59 years	62.2 ± 11.20 years	=0.01
HDL	44.98 ± 9.93	48.02 ± 10.47	0.2
Diastolic blood pressure	82.4 ± 7.02	87.8 ± 6.73	<0.05
Systolic blood pressure	143 ± 8.01	158.6 ± 9.1	0.0019
Triglyceride	111.56 ± 29.27	129.3 ± 34.66	0.28
HbA1c	5.47 ± 1.64	7.67 ± 2.07	<0.0001
Total cholesterol	147.76 ± 47.62	164.32 ± 51.91	0.03
LDL	79.38 ± 46.46	87.92 ± 44.81	0.25
MPV	8.65 ± 0.96	10.17 ± 1.13	<0.05

A noteworthy association between MPV and HbA1c levels was observed in the research findings. The correlation coefficient (r value) was 0.857, indicating a significant correlation. The p-value, which measures the likelihood of this relationship occurring by chance, was less than 0.001, indicating a high level of confidence in the results. Subjects with diabetes exhibit a slightly elevated relationship between HbA1c levels and MPV, but this correlation is almost non-existent in individuals without diabetes.
The levels of triglycerides were somewhat related to the MPV in diabetics but the relationship was not very strong (‘r’=0.09) In non-diabetics, there was a positive relationship between triglyceride levels and MPV, but again, the relationship was not very strong (‘r’=0.03) The relationship between age and MPV was positive, meaning that as age increased, MPV also tended to increase. This association was stronger for people without diabetes compared to those with diabetes. When we compared HDL levels with MPV, we found that there was a negative relationship in both diabetics and non-diabetics. The HDL correlation coefficient (r) was -0.23 for diabetics and -0. 16 for MPV.

DISCUSSION

Stroke incidents happen at a rate of one every 40 seconds. A stroke is the 5th most common reason for people dying and the main reason why people become disabled. When it comes to strokes, they can be classified into two main types: a) Ischemic stroke and b) Hemorrhagic strokes. The primary type of stroke often occurs due to a blockage that hampers the passage of blood to a designated portion of the brain. Around 85% of all sudden strokes are attributed to ischemic stroke. Out of all acute strokes, 15% of them are hemorrhagic strokes. This type of stroke happens when a blood vessel bursts. A severe bleeding episode. Hemorrhagic strokes can be classified into two main types: intracerebral hemorrhage (ICH) and subarachnoid hemorrhage. Subarachnoid hemorrhage makes up about 5% of all strokes. There are many reasons why someone might have a stroke. Some of these include having high blood pressure for a long time, having hardening of the arteries, and having blood clots that formed in the heart because of a heart block. Fibrillation or rheumatic heart disease is a heart condition. In younger patients, there are several reasons that can cause the problem, such as clotting issues, problems with the arteries in the neck, and different types of inflammation in blood vessels.

In the Diabetic group, we found that 17 out of the people in the study (which is 34% of them) drank alcohol, 12 people (which is 24% of them) smoked, and 9 people (which is 18% of them) used tobacco. 22 out of the study subjects (or 44%) had a condition called dyslipidemia, while 38 out of the study subjects (or 76%) had a condition called hypertension. In the group of people without diabetes, 16 out of the 50 subjects (32%) reported drinking alcohol, 13 subjects (26%) said they smoked, and 7 subjects (14%) used tobacco. Out of the people in the study, 48% had dyslipidemia and 82% had hypertension. Chaitanya and colleagues (14) researched 50 patients, and 26 of them had diabetes mellitus. In a study on AIS, Staszewski and his team [10] examined 237 participants, among whom 47 had been diagnosed with diabetes. In their research, they found that the average systolic blood pressure was 149.1 ± 181 and the average diastolic blood pressure was 80.4 with a standard deviation of 10.3. Mohamed and his colleagues [14] studied 157 patients. They found that the average total cholesterol level was 183.4 mg/dl, the average serum triglyceride level was 131.1 mg/dl, the average LDL level was 114.6, and the average HDL level was 39.1.In the diabetic group, the MPV size of platelets was significantly different compared to other groups, according to student's 't' test. The t-value for this difference was 15.22. The p-value is less than 0.0001 which is significant [15]. In their study, Patil et al. [16] found that people with diabetes had higher MPV levels (10.16 ± 0.89 fL level) was elevated in people with diabetes when compared to individuals without the condition (8.25 ± 091 fL; p<0001). An elevated MPV, responsible for blood clotting, was observed in diabetic individuals who experienced a sudden reduction in blood flow to the brain known as acute ischemic stroke. The majority of research [13-19] indicates that people diagnosed with diabetes generally display higher levels of mean platelet volume when compared to individuals who are not affected by diabetes. So basically, MPV is a blood test that shows how well your platelets are working. It can also help predict how bad a stroke will be and what will happen afterwards in people with diabetes. Lok and colleagues found a strong link between a certain blood measurement called MPV and a condition called AIS [20]. They found that diabetics had higher levels of MPV compared to non-diabetics, and this difference was significant with a value of 0.022 The average MPV level in diabetics was measured to be 8.92 ± 103.

CONCLUSION

Diabetic individuals with elevated MPV are at a higher risk of experiencing a stroke, leading to increased vulnerability to severe illness and mortality. Enough research has shown that high MPV values are linked to acute ischemic stroke. The term MPV is also known as a factor that can increase the risk of having a stroke or heart attack in the future. Diabetes is a big

health issue worldwide right now. We found that the shape and behavior of platelets are different in people with Diabetes. These patients displayed an elevated MPV, indicating increased platelet activity. The MPV was a simple measure used in a lab to see how well the platelets are working and it can also help predict the risk of stroke in patients with diabetes. A notable distinction was observed in terms of MPV among individuals afflicted with diabetes and those without the condition, with the former demonstrating significantly higher MPV levels, underlining the statistical significance of this finding. The incidence of AIS (a type of stroke) was higher in diabetes patients who had a larger mean platelet volume.

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