Frequency of Raised Serum Mean Platelet Volume in Patients of Ischemic and Haemorrhagic Stroke

Syed Muhammad Hussain Zaidi1*, Fatima Hasan Jafry1, Masharib Bashar1, Wafa Sohail1, Sohaib Khan Sabih1, Akshay Kumar1, Neelam Kumari Maheshwari1, Prem Shankar1 and Syed Shah Hussain Jafry2

1Dow University of Health Sciences, Pakistan
2Jinnah Sindh Medical University, Pakistan

ABSTRACT

Introduction: Stroke is the second most common cause of death worldwide and is defined as cell death due to interrupted or poor blood supply. It may be caused by a blocked artery (ischemic stroke) or bursting of blood vessel (haemorrhagic stroke). Compared to the United States where 100 cases of stroke are reported annually per 100,000 population, the number is supposedly higher in south Asian countries mounting to a global burden of 40% of stroke related deaths. In the quest for an improved clinical approach and prognosis numerous platelet markers have been investigated in connection with arterial thrombosis and inflammation since platelets are known to play a crucial role in vascular pathologies. Mean platelet volume (MPV), an important variable in this regard is now increasingly being recognized for its clinical significance in both ischemic and haemorrhage stroke. Platelets with larger volume tend to demonstrate increased aggregation as compared to smaller platelets since they can both efficiently respond to and produce chemoattractant cytokines. This new observation has extended the appreciation of the link between stroke and elevated MPV.

Objective: Our purpose of study is to evaluate the frequency of elevated serum mean platelet volume in the patients of ischemic and haemorrhagic stroke and to investigate the possibility of MPV being an independent risk factor for stroke.

Method: A cross sectional study was done on 200 patients of both ischemic and haemorrhagic stroke using a structured questionnaire admitted in the medicine wards (1-5) of civil hospital Karachi (CHK). The Purpose of the research was explained and history based questions asked. Assessment of stroke was inferred from the patients file. Blood pressure, pulse and RBS and CBC values entered during admission were noted. ‘Glasgow Coma Scale’ was used to assess the conscious state of a person for neurological status. A standard phlebotomy technique was used to collect samples and results given by an automated analyser. Students t-test and Chi-Square was used to analyse the data through SPSS Version.16.

Result: Out of total 200 stroke patients, 107 (53.5%) were of ischemic stroke and 93 (45.5%) haemorrhagic stroke. There were 56.5% male (49.4% ischemic and 64.5% haemorrhagic) and 43.5% female (50.5% ischemic and 35.5% haemorrhagic). MPV in ischemic stroke was 10.9 (SD 1.29) and haemorrhagic stroke was 11.0 (SD 1.5)

Conclusion: On comparison of MPV in both ischemic and haemorrhagic, the p-value was 0.542 which was statistically insignificant

KEYWORDS: Platelets; Mean platelet volume; Hypertension; Stroke; Thrombosis; Inflammation; Prognosis
INTRODUCTION

Background

Pakistan is home to 2.6% of the world’s population with an estimate of approximately 195 million according to United Nations by 2017 [1]. It is also amongst one of the leading South Asian countries that carries a significant burden of cardiovascular diseases. One out of every 4 adults has either hypertension, type 2 diabetes or cardiovascular disease each of which hold extreme significance in the development of stroke. Literature search shows that there have not been much large-scale epidemiological studies that could be helpful in determining the actual incidence of stroke in Pakistan [2]. Estimated annual incidence is 250/100,000 translating to 350,000 new cases every year [3]. Both haemorrhagic and ischemic stroke are one of the most frequent causes of admissions in neurology ward in our setup. The lifestyle and dietary habits including gutka, oral tobacco, and betel nut are potentially unique risk factors along with smoking, hypertension, diabetes, dyslipidemia and ischemic heart disease that exist in Pakistan and provide rationale for further investigation [4]. In the recent years lot of development has taken place in the clinical approach, diagnostic work up and management of stroke that has resulted in a significant decline in its mortality and morbidity [5]. One of the most crucial progress that has been witnessed in this regard is the usage of simple clinical laboratory techniques as indicators for stroke. This has opened horizons which can provide us with a better understanding of this complex clinical entity. Platelet size measured as mean platelet volume or serum MPV is defined as the average volume of the platelets ranging from 7.5fl – 11.5fl [6]. Being one of the parameters of the complete blood count report (CBC), serum MPV values are carried out as a part of routine laboratory investigations during every hospital admission. It is a marker of platelet function and is positively associated with indicators of platelet activity including aggregation and release of thromboxane A2, platelet factor 4 and β-thromboglobulin [7]. Increases in MPV reflect a proportional increase in platelet reactivity. Larger platelets contain denser granules and express an increased number of p-selectin and GP IIb/IIIa receptors and tend to coagulate more rapidly to agonists [8]. The increase in platelet size in conjunction with elevated Platelet count (PC) increases the thrombotic potential [9]. Since thrombosis and inflammation play a key role in pathophysiology of stroke [10]. Therefore, previous studies have proved pivotal in establishing the relationship between the two. Elevated MPV is a characteristic feature in patients of ischemic stroke than in control subjects. It is present well before the acute event and also persists during the long-term recovery period [11]. In contrast the correlation of MPV with hemorrhagic stroke has been variable and only platelet count has been reported to play a role in the outcome. Hypertension is the single most important risk factor that has contributed immensely to the global burden of stroke. Gang et al. [12] determined the prognostic value of MPV for hypertension which predicted that elevated MPV was associated with increased incidence of hypertension which suggests that platelet activity may play a role in hypertension.

Objectives

The main objectives of our study were to consider MPV value as a prognostic and therapeutic marker and to look at the factors influencing its value in stroke patients. The measurement of MPV adds useful prognostic information for clinicians managing patients with a history of cerebrovascular disease. It might also help to predict outcome in patients at increased risk of a severe course of acute cerebrovascular disease independent of other clinical parameters. Lifestyle modifications, diet changes and intake of lipid lowering agents and anti-inflammatory drugs have also resulted in altered levels of MPV [13]. This warrants further insight into the future implications of mean platelet volume in long term management of stroke. It is noteworthy that not much data is found in the local articles pertaining to the aforementioned association.

Rationale

The primary aim of our study was to investigate the frequency of raised MPV, a readily available parameter of platelet activation in patients of ischemic and haemorrhagic stroke. We also considered risk factors and the assessment of stroke on the that can result in confounding changes in the serum mean platelet volume.

METHODOLOGY

Study Design

This was a cross sectional study.

Study Population and Study Setup

The study was done on stroke patients admitted in the ward and the intensive care units of medical department (1-5) of civil hospital Karachi. (CHK).

Inclusion Criteria

a) Patients of both gender with ages between 20 and 60.
b) Patients diagnosed with ischemic or haemorrhagic stroke on either CT or MRI.
c) Patients giving consent for participation.

Exclusion Criteria

a) Patients with malignancy or underlying blood pathology.
b) Patients with viral haemorrhagic fever.
c) Patients taking anticoagulants or antiplatelet drugs.
d) Patients with bleeding diathesis.
e) Patients not giving consent.

Operational Definitions

Mean platelet volume: It is a machine calculated measurement of the average size of platelets found in blood and is typically included in blood tests as part of the complete blood count.

Ischemic stroke: It is a type of stroke in which blood supply to a part of brain is decreased as a result of occlusion within a blood vessel supplying that part, leading to dysfunction of the brain tissue in that area.

Haemorrhagic stroke: It is a type of stroke which occurs when a weakened vessel in the brain ruptures leading to either intraparenchymal or intraventricular bleeding.

Sample Size

| Confidence interval (2-sided) | 95% |
|------------------------------|-----|
| Power                        | 80% |
| Ratio of sample size (Group 2/Group 1) | 1 |

| Group 1 | Group 2 | Difference* |
|---------|---------|-------------|
| Mean    | 9.996   | 0.3         |
| Standard deviation | 1.81 | 1.7         |
| Variance | 3.2761 | 2.89        |
Sample size of group 1 538
Sample size of group 2 538
Total sample size 1076

*Difference between the means

Sample Technique

Our sampling was done through a standard phlebotomy technique and the results were given by an automated analyser.

Duration of Study

The study duration was of 6 months from September 2016 to February 2017.

Study Tools

The study tool was a self-designed questionnaire which was used by the investigators to interview the study participants. The questionnaire was not translated into another language since a major part of the questionnaire required clinical parameters which had to be completed by the researchers themselves. The questionnaire consisted of 4 parts with both subjective and objective variables. The first part of the question template comprised of general demographics namely age, sex, marital status, mode of admission, occupation. The second part interrogated targeted history questions with regard to comorbidities (diabetes, ischemic heart disease, dyslipidemia and hypertension), addictions (gutka, tobacco, betel nuts, smoking). It also included a drug history categorically divided into 2 main classes of drugs i.e antihypertensives and antidiabetogenic, (oral hypoglycemic or insulin). The questions in the second part were merited a score of ‘1’ for yes and ‘0’ for no.

The rest of the questionnaire dealt primarily with objective variables. The 3rd part determined a general assessment of stroke by inquiring about the duration of stroke and the presence of neurological deficits mainly dysphagia and hemiplegia. The GCS scale was used as a reliable marker to gauge the conscious level of the patient with a ‘9’ cut off value. Levels above 9 were classified as mild/normal while below 9 was taken as a severe GCS. In addition, imaging studies comprising of computed tomography (CT) and magnetic resonance imaging (MRI) were used as diagnostic modalities to determine the type of stroke present. The last part of the questionnaire was related to vitals and complete blood count as measured from the patients file records at the time of admission.

Data Collection Plan

The survey was conducted by taking informed consent from the patients or their attendants in case of comatose patients. The purpose of the research was explained and the history-based questions in our questionnaire were asked. The neurological status was assessed by using the standard Glasgow Coma Scale (GCS). Vitals were taken and stroke was diagnosed through CT or MRI scan of the Brain. Collection of venous blood samples were taken from a visible vein on arms in tubes containing anticoagulants (sodium, fluoride and K3ETDA) for Haemoglobin, White blood cell count, Mean platelet volume and Platelet count. The procedure was done by trained phlebotomists under aseptic conditions through standard phlebotomy technique.

Statistical Analysis

Data is grouped into two groups, group 1 as Ischemic stroke and group 2 as Haemorrhagic stroke. Mean and standard deviation is calculated for continuous variables like age, MPV, BP, Platelet count and Random blood Sugar. Students t-test is applied for continuous variables in two groups. Chi-square test is applied to see the association of ischemic and haemorrhagic stroke to mean platelet volume.

Ethical Considerations

The study took place after permission from the management of the respective department. The participants were recruited in the survey after taking informed consent and the purpose underlying the research was explained thoroughly in urdu language. All the information collected was anonymous and all the data gathered was kept private and confidential.

RESULTS

| Variables | % in Haemorrhagic | % in Ischemic | Total % | P-Value |
|-----------|------------------|--------------|---------|---------|
| Age < 45  | 21.5             | 12.1         | 16.5    | 0.087   |
| Age > 45  | 78.5             | 87.9         | 83.5    | 0.087   |
| Male gender | 64.5         | 49.5         | 56.5    | 0.045   |
| Female gender | 35.5         | 50.5         | 43.5    | 0.045   |
| Diabetes Mellitus | 26.5     | 45.8         | 37      | 0.008   |
| IHD*      | 19.4             | 29.9         | 25      | 0.102   |
| Dyslipidemia | 10.8         | 25.2         | 18.5    | 0.01    |
| HTN**     | 73.1             | 59.8         | 66      | 0.053   |
| Anti-HTN**| 45.2             | 46.7         | 46      | 0.88    |
| Anti-DM***| 16.1             | 32.7         | 25      | 0.009   |
| Gutka     | 14               | 12.1         | 13      | 0.834   |
| Betel nuts| 26.8             | 25.2         | 25.5    | 1       |
| Tobacco   | 8.6              | 21.5         | 15.5    | 0.018   |
| Smoking   | 28               | 21.5         | 24.5    | 0.325   |

Abbreviations; IHD*= Ischemic Heart Diseases, HTN**= Hypertension, Anti-HTN**= Anti-Hypertensive, Anti-DM***= Anti-Diabetics
Two hundred (200) patients of Ischemic and Haemorrhagic stroke who had the inclusion and exclusion criteria fulfilled were prospectively documented, out of which 107 were patients of Ischemic stroke and 93 were patients of Haemorrhagic stroke. Demographic characteristics and clinical variables were compared between the two study groups in Table 1. 83.5% of patients were above 45 years of age out of which majority (87.9%) were of ischemic stroke with an insignificant p-value of 0.087 between the two groups. Higher proportion of males being 56.5% in total and 64.5% were patients of haemorrhagic stroke whereas females had a higher percentage of ischemic stroke, there was a positive correlation seen between the gender groups (P=0.045). 37% of the patients were known diabetics and there was statistical significance of raised MPV [p=0.008], percentage being higher with ischemic strokes (45.8%). Similar association was seen with tobacco addicts (15.5%) in ischemic strokes (21.5%) with indicative relation of raised Mpv [p=0.018]. There was positive association in patients of dyslipidemia and on anti-diabetics [p=0.01 and p=0.009 respectively]. There were no remarkable differences in patients with Ischemic heart diseases, on anti-hypertensive, addicts of gutka, betel nuts and smoking in both study groups taken. The association of MPV with neurological deficits was examined in Table 2. There was a positive relation of GCS with high percentage (43.8%) of patients with increased MPV but no significant p-value [p=0.27]. None of the other neurological variables had an effect on MPV or p-value.

Table 2: Association of MPV with neurological deficits.

| Variables | % with normal MPV | % with increase MPV | p-value |
|-----------|-------------------|---------------------|---------|
| Dysphagia | 66.7              | 60.9                | 0.555   |
| Hemiplegia | 85.2              | 79.7                | 0.56    |
| GCS       | 33.3              | 43.8                | 0.27    |

Table 3: Relationship of vitals with type of Stroke.

| Findings on Scan | N  | Mean    | Std. Deviation | Std. Error Mean | P-Value    | 95% Confidence Interval |
|------------------|----|---------|----------------|-----------------|------------|-------------------------|
|                  |    |         |                |                 |            |                         |
| GCS              |    |         |                |                 |            |                         |
| Hemorrhagic      | 93 | 10.2366 | 3.35701        | 0.34811         | 0.014      | 0.22322-2.0539          |
| Ischemic         | 107| 9.0935  | 3.16982        | 0.30644         |            |                         |
| Systolic BP      |    |         |                |                 |            |                         |
| Hemorrhagic      | 93 | 1.586+02| 36.46325       | 3.78106         | 0.006      | 3.9894-23.5326          |
| Ischemic         | 107| 1.44E+02| 33.58547       | 3.24683         |            |                         |
| Diastolic BP     |    |         |                |                 |            |                         |
| Hemorrhagic      | 93 | 94.8925 | 23.72829       | 2.46051         | 0.107      | -12.7324                |
| Ischemic         | 107| 89.6636 | 21.90716       | 2.11784         |            |                         |
| Pulse            |    |         |                |                 |            |                         |
| Hemorrhagic      | 93 | 86.7312 | 13.76364       | 1.42722         | 0.292      | -82819.0479             |
| Ischemic         | 107| 88.8411 | 14.36003       | 1.38824         |            |                         |
| RBS              |    |         |                |                 |            |                         |
| Hemorrhagic      | 93 | 1.63E+02| 86.15647       | 8.93401         | 0.285      | -47.1047                |
| Ischemic         | 107| 1.76E+02| 82.54941       | 7.98035         |            |                         |
Table 3 shows relationship of vitals in stroke subtypes and their relation to outcome of mpv with the mean and std. deviation and 95% confidence interval. The GCS was found to be better in Haemorrhagic as compared to Ischemic with the mean of 10.23 and was significant with \( p = 0.014 \), 95%CI= 0.22-2.05. Similarly, Systolic BP was positively correlated with a significant association in Haemorrhagic stroke patients with the mean=1.57 and \( p = 0.006 \) with CI= 3.98-23.5, but diastolic BP was not found to be suggestive. Pulse and RBS were not related to significant differences in the mean or \( p \)-value but there was negative 95%CI in both.

The relationship of haematological variables with the stroke subtypes were compared in Table 4 and were significantly associated with type of stroke and correlation was markedly found with haemoglobin% being higher for haemorrhagic (\( m=13.0 =_2SD \)) than ischemic (\( m=12.19 +_2SD \)) with \( P= 0.018 \) and 95% CI= 0.14-1.53.

Comparison of MPV in the two groups showed higher upper levels of MPV in patients with Haemorrhagic stroke as compared to ischemic stroke patients with the mean MPV values of 11.02 femtoliter and 10.9 femtoloter respectively. No positive correlation was found with the \( p \)-value (.542) with 95%CI= -0.27-0.5.

**DISCUSSION**

Although, the incidence of stroke is falling in the West, it is rising in South Asia (India, Pakistan, Bangladesh, etc.). The burden of stroke risk factors in Pakistan is enormous e.g. by 2020 Pakistan will be 4th most populous country in terms of diabetic patients [14]. Although there are no well-designed, population-based published studies related to stroke prevalence in Pakistan [15] the estimated annual incidence of stroke in Pakistan is 250/100,000, which is projected to an estimate of 350,000 new cases every year [16].

Our study aimed to investigate the relationship between MPV and the development of either hemorrhagic or ischemic type of stroke. Since, most of the local studies on MPV seems to be lacking significantly, this study, keeping in view the increasing prevalence of stroke in our country, will help in understanding the different variables associated with development of either type of stroke.

The mean platelet volume is related to platelet activation and it has been suggested as a marker of haemostasis [17]. Larger platelets are more densely granulated, and they are metabolically more active than smaller ones. Increases in MPV levels lead to increased secretions of the prothrombotic agents; thromboxane A2, serotonin, \( \beta \)-thromboglobulin, the procoagulant surface protein P-selectin and glycoprotein-IIIA [18,19]. Platelet size is determined at the level of the progenitor cell (i.e., the megakaryocyte), and previous studies reported that cytokines such as interleukin-3 or interleukin-6 influence megakaryocyte ploidy and can lead to the production of more reactive, larger platelets [20-22]. It is therefore reasonable to speculate that a proinflammatory state before the cerebrovascular event may confer a higher MPV and a prothrombotic state.

**Table 4: Relationship of labs with type of stroke.**

| Findings on scan | N  | Mean  | Std. Deviation | Std. Error Mean | P-Value | 95% Confidence Interval |
|------------------|----|-------|----------------|-----------------|---------|-------------------------|
| CBC HB%          |    |       |                |                 |         |                         |
| Hemorrhagic      | 93 | 13.034| 2.3612         | 0.24485         | 0.018   | 0.1476-1.5319           |
| Ischemic         | 107| 12.1942| 2.57111        | 0.24856         |         |                         |
| WBC              |    |       |                |                 |         |                         |
| Hemorrhagic      | 93 | 12.8549| 5.40337        | 0.5603          | 0.443   | -3.2452                 |
| Ischemic         | 107| 12.2228| 6.13066        | 0.59267         |         |                         |
| Platelets        |    |       |                |                 |         |                         |
| Hemorrhagic      | 93 | 2.65E+02| 113.1927      | 11.73753        | 0.868   | -73.6982                |
| Ischemic         | 107| 2.68E+02| 146.3219       | 14.14547        |         |                         |
| MPV              |    |       |                |                 |         |                         |
| Hemorrhagic      | 93 | 11.0283| 1.50928        | 0.1565          | 0.542   | -0.7897                 |
| Ischemic         | 107| 10.9072| 1.29084        | 0.12479         |         |                         |
The Mean platelet volume (MPV) is part of the Complete Blood Count (CBC) tests and it identifies the average size of platelets found in the blood of an individual. The test is specifically used to show the relationship between the production of platelets in the bone marrow or incidence on the destruction of platelets. A level of 7.5-11.5 femtoliters (this is one quadrillionth of a litre) is the normal range for mean platelet volume in most cases. This range is however, subject to many other factors. In order to determine the most favourable range for specific individuals, there are factors that must be considered. One factor includes things such as geographical aspects of the area where the individual resides. For instance, people in the Mediterranean region have shown to display a higher MPV than those in some other geographical regions.

High Mean Platelet Volume (MPV) with a low platelet count are seen in conditions that leads to massive destruction of platelets in the blood (e.g. immune thrombocytopenia). This is because in case of increased destruction, the marrow produces more platelets, more quickly; thus, reducing the transit time of the megakaryocytes within the marrow and hence, decreased fragmentation, resulting ultimately in larger-sized platelets. Each megakaryocyte produces a total of 1000 to 3000 platelets [23].

High Mean Platelet Volume (MPV) with normal platelet count can be a sign of chronic myeloid leukaemia, a condition in which there is overproduction in a particular type of white blood cells. A condition known as hyperthyroidism may also be evident when MPV is high with a normal platelet count. This is a condition in which there is excessive production of thyroid hormones.

When a high MPV is accompanied by a high platelet count, it's an indication that the bone marrow is producing the platelets in excess, while low MPV with low platelet count is an indicator of marrow hypofunction e.g. aplastic anemia. Low MPV may also reflects decreased platelet reactivity and hence, tendency to overbleed is seen in such patients.

Previous studies conducted showed a positive correlation between MPV and ischemic stroke [24-27]. Bath et al. in their study reported that MPV is primarily associated with ischemic stroke, but there is no association between MPV and hemorrhagic stroke and strokes with unknown cause [28-30]. However, in another study that investigated only the relationship between MPV and hemorrhagic stroke, MPV was reported to have prognostic impact [31,32] Our study though, failed to show any association between MPV and the type of stroke. This is because, due to the limitations of small sample size (n=200) as compared to the initial target of 1000, because of time-constraint and the limitation of data collection from only one hospital, in the allocated amount of time. We intend to continue this study until the initial adequate sample size has been reached and only then, we will be able to comment on the relationship more accurately. However, logically speaking, one is more likely to find elevated MPV in ischemic strokes since, it reflects increased platelet reactivity and more chances of platelet clumping together, causing clot formation.

With regard to the relationship between MPV and platelet count, it has been shown in several studies that the relation is inverse, as documented by Molley [33]; Icme et al. [34]; Greisegregger [35] in their respective studies. This is may be due to the same reason, that higher MPV indicates decreased transit time of platelet precursors through the marrow and hence, decreased fragmentation, resulting in lower platelet numbers. Our study however, failed to show any such association.

Significant correlation was seen between elevated hemoglobin levels and type of stroke, with levels being much higher in hemorrhagic stroke. However, hematocrit (Hct) levels have been more actively studied in stroke patients than Hb levels, mainly with regard to the question of viscosity and cerebral blood flow [36]. Extremes of hemoglobin values post-stroke are both associated with worse performance after stroke [37] and hence, must be maintained adequately. Higher hemoglobin levels may be associated with worse stroke symptoms because of hemococoncentration and dehydration, and high hemoglobin may be a marker of poor volume status. The finding of elevated Hb in hemorrhagic stroke may be indicative of increased plasma osmolality secondary to volume depletion [38] or may even represent hyperviscosity of blood [39].

With regard to the vitals, we found significant association between higher GCS score and hemorrhagic stroke and very significant correlation between hemorrhagic stroke and elevated systolic BP (>140 mm Hg).

The Glasgow Coma Scale (GCS) is used to describe the general level of consciousness in patients with traumatic brain injury (TBI) and to define broad categories of head injury. The GCS is divided into 3 categories, eye opening (E), motor response (M), and verbal response (V). The score is determined by the sum of the score in each of the 3 categories, with a maximum score of 15 and a minimum score of 3. The GCS score was found to be an accurate predictor of mortality after acute ischemic stroke and was equal in prediction to the NIHSS [40], while the NIHSS is more accurate than the GCS score in predicting poor neurologic outcome [41]. With regard to our study, there may be multitude of reasons as to why better GCS was seen in hemorrhagic strokes, because, paradoxically it has been seen that primarily, hemorrhagic ones are associated with greater risks of mortality and increased stroke severity [42]. This might be because GCS score is dependent on many factors, most commonly the expertise of the examiner, size of the lesion, effects of current treatment and effects of other injuries or lesions. Underlying chronic conditions may also affects the scoring of GCS.

Hypertension is the most important modifiable risk factor for stroke [43,44]. It is estimated that 25% or more of strokes may be attributable to hypertension [45]. Lowering BP reduces the risk of stroke. Epidemiological studies have shown that for each 10 mm Hg lower systolic blood pressure (SBP), there is a decrease in risk of stroke of approximately one third in persons aged 60 to 79 years [46]. This association is continuous down to levels of at least 115/75 mm Hg and is consistent across sexes, regions, stroke subtypes, and for fatal and nonfatal events [47]. Lowering diastolic blood pressure (DBP) was once the main target to achieve stroke and other cardiovascular event reduction, but SBP has now become the target. As recently shown, even the elderly with sustained SBP elevation may gain from BP reduction in relation to less fatal or nonfatal stroke, death, and heart failure elevated BP over a period of time cause increase stress on the inner layers of blood vessels, and decreases the perfusion of vasa vasorum rendering the medial layers of blood vessels weaker and more prone to rupture. Furthermore, weaker vessels may dilate and form aneurysms which are also more vulnerable to rupture. It is because of this reason that higher BP is related to incidence of hemorrhagic strokes. Endothelial cell damage over time may also cause inflammatory cells, platelets and fatty deposits to accumulate at those sites, causing thrombus formation which over time, may become sufficiently larger to occlude the entire vessel, causing ischemic stroke. Thus, elevated BP down the road, can cause any type of stroke.
No significant relationship was found between type of strokes and other vitals (diastolic BP, pulse and RBS). Similarly, no relation was found between elevated MPV and neurological symptoms of hemiplegia and dysphagia, nor the association between GCS and MPV.

In our study, we also investigated the type of strokes and their association with history-based variables and demographics. Significant association was found to be between gender and stroke type, with male gender showing greater incidence of hemorrhagic while females showing greater incidence of ischemic strokes. This was consistent with the findings of Hsieh et al. [39]. Moreover, in a study from the WHO MONICA project, the populations from Eastern Europe and Finland had higher incidence rates of SAH in men than in women. These findings in our study, maybe perhaps, due to the fact, that our study had greater percentage of people above the age of 45 (83.5%), which may reflect decreased protective effects of estrogen in females, since we can assume most of the women will either be perimenopausal or post-menopausal. Endogenous estrogens decreases the risk of thromboembolism and hence, menopause is going to take away that protection, increasing risk of ischemic strokes.

Significant correlations were also found between increased incidence of ischemic strokes and their association with diabetes mellitus, dyslipidemias and tobacco addiction. As published by Bruno et al. [41] DM increases risk of ischemic strokes through various phenomena. Diabetes mellitus, due to chronic hyperglycemia, has been linked with accelerated development of both microvascular disease and atherosclerosis throughout the body. Advanced glycation end product formation interacts with specific receptors that lead to overexpression of a range of cytokines. Furthermore, hyperglycaemia, non-enzymatic glycosylation, lipid modulation, alteration of vasculature and growth factors activation contribute to development of diabetic vasculopathy.

Many studies have pointed out a link between dyslipidemia emias and increased risk of ischemic stroke. Elevated LDL levels and decreased HDL levels may cause increase in the levels of triglycerides and cholesterol in our body, making it a risk factor for development of atherosclerosis too, which ultimately leads to development of ischemic stroke. Increased expression of adhesion cell molecules is considered to be a marker of endothelial cell dysfunction. An increase in cell adhesion molecules has been noted in patients with hypertriglyceridemia.

The role of tobacco only in the pathogenesis of ischemic stroke is less clear with different studies. However, it seems plausible that nicotine in tobacco increase the risk of cardiovascular events via vasoconstriction, increased platelet aggregation and decreased effect of fibrinolytic processes which may explain the finding.

LIMITATIONS

a) We had a limited amount of time to complete our research so for our sake of convenience we reduced our sample size from 1076 to 200 out of which 107 were patients of ischemic stroke and 93 were of haemorrhagic stroke. We would like to continue this research further and complete it with the exact sample size.

b) Our study setup was restricted to Civil Hospital Karachi (CHK).

CONCLUSION

Our study rationale centered primarily around the frequency of MPV values in ischemic and hemorrhagic stroke along with the addition of factors influencing both type of stroke. The data revealed no significant association between MPV in both ischemic and hemorrhagic stroke in contrast to previous researches conducted on the same entity however our sample size was limited to 200 so we cannot comment on the significance of the association. Nonetheless the statistical values drew some important conclusions regarding the magnitude of factors we included in our study in relation to stroke. Male gender predominance, elevated Hb, systolic BP greater than 140, and GCS above 9 were outlined to be notable in hemorrhagic stroke. The significance of BP can be explained as elevated BP over time causes increased stress which leads to blood vessels to become weaker and more prone to rupture, and this increasing the incidence of hemorrhagic stroke. Ischemic stroke showed strong correlation with diabetes, dyslipidemia, and tobacco addictions. In diabetes mellitus, advanced glycation end product formation leads to overexpression of a range of cytokines and growth factors along with alteration of vasculature contributing to diabetic vasculopathy. Similarly, nicotine in tobacco causes vasoconstriction that ultimately leads to increased risk of cardiovascular events. This may explain their association with ischemic stroke.

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RECOMMENDATION

a) Doctors should encourage patients to visit clinic for general evaluation at a regular time interval to prevent development of secondary complications.

b) Doctors should play an active role by encouraging patients to join stroke rehabilitation program. The purpose behind such initiative is to help survivor understand and adapt to difficulties.

c) The awareness regarding life-style modifications including diet changes and exercise should be increased on a community level using media resources such as newspapers, magazines, seminars, brochures and social websites like facebook and twitter.

d) Family members should be educated to play a supporting role if the patient experiences stress over his/ her condition. Psychologist treatment should be sought in case the patient develops post-stroke depression.

e) Physiotherapists can also work with patients to improve awareness and use of the hemiplegic side. Rehabilitation should be directed towards the ability to produce strong movements or to perform tasks using normal patterns.

f) Similar researches should be carried out on larger scales with better resources to identify other clinical variables that could be helpful in the prognosis and early detection of stroke.

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