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**TITLE: Analysis of hematological parameters in ischemic and hemorrhagic stroke in cerebrovascular accident cases**

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### **Abstract:**

**Background:** Cerebrovascular accident is an injury to the brain as a result of altered blood flow leading to sudden focal neurological deficit. Some laboratory findings have been proposed as prognostic factors. Also, laboratory findings have been a part of prognosis estimation in many studies. This Study was proposed to study the hematological parameters in ischemic and hemorrhagic infarcts.

**Methodology:** This study was done as a retrospective descriptive study at Saveetha Medical College, during the period of December 2020 and May 2021. The study includes 130 CVA cases, of which 83 were ischemic and 47 were hemorrhagic cases. Hematological parameters were obtained using Sysmex Automated Analyzer XN-1000. Statistical analysis was done by SPSS software version 23, with descriptive and independent t test. The level of significance was taken as p value < 0.05.

**Results:** The common age group of CVA ranges from 51-60 years in ischemic infarct and 58-66 years in hemorrhagic infarct. Both ischemic and hemorrhagic stroke have a slight male preponderance. Most hematological parameters including Hb, RDW, MCH, MCHC, TC, neutrophils showed significant changes on comparing ischemic and hemorrhagic infarcts. Platelet count, PDW and PCT also had significant difference:

**Conclusion:** In this study, hematological parameters of CVA patients were greatly altered. Platelet indices had more significance. Furthermore similar studies has to be done comparing ischemic and hemorrhagic infarcts as these are easily available, cost-effective to predict the onset and prognosis of stroke.

**Keywords:** Stroke, ischemic, hemorrhagic, hematological indices.

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**Introduction:**

Cerebrovascular accident is an injury to the brain as a result of altered blood flow leading to sudden focal neurological deficit. It is etiologically classified to ischemic and hemorrhagic stroke. Ischemic stroke is due to impairment of blood supply and oxygenation of the CNS tissue whereas hemorrhagic stroke is due to rupture of CNS blood vessels. In India, the estimated adjusted prevalence rate of stroke range 84-262/100000 in rural and 334-424/100000 in urban areas. The incidence rate is 119-145 /100000 based on recent population based studies<sup>1</sup>

Stroke is a sudden loss of neurologic function resulting from focal disturbance of cerebral blood flow due to ischemia or hemorrhage<sup>2</sup> in elderly people.<sup>3</sup> Acute ischemic stroke represents a common and challenging disease with increasing morbidity despite decreasing mortality.<sup>4</sup> Ischemic Stroke, in which blood flow to the brain is blocked by blood clots or fatty deposits called plaque in blood vessel linings. It is also caused by occlusion of an artery in the neck or in the brain, depriving a part of the brain of its nutrients, glucose and oxygen. When an ischemic stroke occurs, the blood supply to the brain is interrupted, and brain cells are deprived of the glucose and oxygen they need to function.<sup>5</sup>

Hypertension, carotid artery stenosis, atrial fibrillation and certain other cardiac conditions, cigarette smoking, diabetes mellitus, dyslipidaemia, sickle cell disease, poor diet, physical inactivity, and obesity are well-established risk factors for ischemic stroke.<sup>6,7</sup> Less well-established risk factors include alcohol and drug abuse, the metabolic syndrome, oral contraceptive use, sleep-disordered breathing, migraine and hypercoagulability. The greatest stroke risk, however, occurs in those with previous transient ischemic attack or previous stroke.<sup>8</sup>

Some laboratory findings have been proposed as prognostic factors. Also, laboratory findings have been a part of prognosis estimation in many studies; for example, red cell distribution width (RDW) is used to predict the functional outcomes and severity of cerebrovascular events.<sup>9</sup>, although not all studies confirm this fact<sup>10</sup>. Also, it has been proposed that mean platelet volume (MPV) may indicate the prognosis of ischemic stroke. This Study was proposed to study the hematological parameters in ischemic and hemorrhagic infarcts.

### Methodology:

A retrospective study was carried out in line with research regulations, including the approval of the Ethical Committee. Total of 130 patients with CVA changes of which 83 ischemic cases and 47 hemorrhagic cases are taken for this study obtained during the period of December 2020 and May 2021. CVA due to ischemic and hemorrhagic causes were also studied and the diagnosis was obtained by clinical history and radiological findings. Demographic data was obtained from the patients' medical records and estimation of hematological parameters was done by Sysmex Automated Hematology Analyzer XN-1000 from the department of Hematology, obtained during the time of admission.

This study was approved by Ethics Committee of our institute. As this study was a retrospective study, there was no patient's privacy data such as patient name, ID number, telephone and address were involved. Only demographic information and laboratory testing data of patients were collected and analyzed in this study.

The SPSS, version 24 was used for the data processing. All the values were expressed as mean $\pm$ standard deviation unless otherwise indicated. The differences in the mean values between the groups were analyzed by using the Student's t-test. A p-value of <0.05 was considered statistically significant.

### Results:

In our study of 130 patients mean age was 58.38 years in patients in ischemic group and 57.80 years in hemorrhagic group. There was no significant difference between ages between two types of stroke.

In our study, 84 were male patient and rest 46 were female patient. Among 84 male 54 had ischemic stroke and rest 30 had hemorrhagic stroke. Among females 29 had ischemic stroke and 17 had hemorrhagic stroke.

**Table 1: Demographic features**

Age	Ischemic	Hemorrhagic
Mean	58.38 $\pm$ 10.48	57.80 $\pm$ 13.89
Sex	Ischemic(83)	Hemorrhagic(47)
Male	54	30
Female	29	17

In our study we did all hematological parameters and compared between two different types of stroke. Among all parameters analyzed Hemoglobin was significantly less in ischemic infarct in comparison with hemorrhagic infarct. Similarly Red cell distribution width was low in ischemic type in comparison with hemorrhagic type. This was also significant. All other red cell indices did not depict any significant difference

Platelet count was significantly low in hemorrhagic stroke when compared to ischemic type. Platelet indices like Mean platelet volume and plateletcrit was significantly low in hemorrhagic type.

Coming to white blood cells, total count and neutrophils were less in ischemic type and this was significant too. Other white blood cell indices was not significant

**Table 2: Comparison between hematological indices.**

S.No	HEMATOLOGICAL PARAMETERS	ISCHEMIC INFARCT	HEMORRHAGIC INFARCT	P VALUE
1	Hb	10.07±2.62	11.813±2.54	<0.001
2	RBC	4.474±0.786	4.265±0.817	0.159
3	PCV	38.425±7.27	37.185±11.04	0.497
4	MCV	83.106±13.69	86.047±11.04	0.184
5	MCH	26.935±4.66	28.304±3.44	0.05
6	MCHC	30.899±3.01	32.123±2.27	0.01
7	RDW	14.927±4.44	18.948±2.75	<0.001
8	Platelet	2.733±0.808	1.017±0.804	<0.001
9	TC	11162.747±3022.29	14764.149±5074.092	0.001
10	Neutrophil	74.341±11.828	79.315±14.130	0.044
11	Lymphocyte	18.875±9.95	21.049±11.516	0.281
12	Eosinophils	3.19±3.75	2.234±3.18	0.126
13	Monocytes	4.534±1.86	5.323±2.594	0.071
14	Basophils	0.241±0.168	0.260±0.236	0.628
15	MPV	11.023± 1.051	9.7± 1.206	<0.001
16	PCT	0.290±0.031	0.241±0.011	<0.001

**Discussion:**

Stroke is a manifestation of clinical symptoms of focal and global disturbance in brain functions. There are several studies related to blood parameters in ischemic stroke. Although not much of studies in blood parameters of hemorrhagic stroke, this study is done to compare the ischemic and hemorrhagic blood parameters.

In our study of 130 patients mean age was 58.38 years in patients in ischemic group and 57.80 years in hemorrhagic group. There was no significant difference between ages between two types of stroke. Age and gender specific prevalence of risk factors in patients with first ever ischemic stroke was observed in china.<sup>11</sup> They concluded that prevalence of ischemic stroke was higher in both male and female patients <80years of age. Non-significant difference was observed in mean age of ischemic stroke patients and control similar study was reported by Bill et al.<sup>12</sup>

In our study, Hb levels were decreased and platelet count was increased in ischemic stroke compared to hemorrhagic stroke. These results coincides with Sharif et al<sup>13</sup> which showed the same results compared to normal control group. During ischemic stroke erythrocyte undergoes oxidative and proteolytic changes resulting in a changed cellular rheology and inflammatory process. The mechanism by which lower hemoglobin associates with stroke was unknown. However, one possible explanation is through its influence on energy supply. Hemoglobin carries 98% of the total blood oxygen, yet within one standard deviation of the normal range that the level may vary by as much as 20%<sup>14</sup>. The result was significantly impaired in the ischemic brain with limited ability of the brain to increase the extraction of available oxygen. Available evidence in animal models of ischemic stroke suggests that lower hemoglobin reduces the threshold for ischemia and results in larger infarct volumes.

In our study, RDW was increased in hemorrhagic stroke than ischemic stroke correlating with Wang et al<sup>15</sup> which concluded that elevated RDW level was related to increased risk of hemorrhagic transformation among acute ischemic stroke patients without reperfusion therapy. MCH and MCHC also should significant results.

Platelet indices- platelet count, MPV, PCT was raised in ischemic stroke than hemorrhagic stroke similar to that of Sankaretal<sup>16</sup> which compared with a control group. The result implies that enhanced platelet responsiveness and persistent systemic activation of

circulating platelets is a critical mechanism in the pathophysiology of acute cerebrovascular disease. Platelets play a critical role in acute and chronic inflammation. Platelet activation plays a pivotal role in the pathogenesis of thrombotic vascular disorders, such as ischemic stroke and TIA.

Total leucocyte count was increased in hemorrhagic compared to ischemic stroke which might be a predictor of prognosis of stroke as concluded by Furlan et al <sup>17</sup> which said that the presence of leukocytosis could indicate a concomitant infection in patients with acute ischemic stroke and is an independent predictor of less favorable post-stroke prognosis. The increased in WBC count may be due to the mobilization of the leukocyte marginal pool as an inflammatory response to the ischemic damage to brain parenchyma. Also an increased expression of a wide range of cytokines and chemokine precedes WBC infiltration.

### **Conclusion:**

It was concluded that blood parameters potentially able to impair the cerebral circulation. In many studies, platelet indices showed significant changes and preferred to be used as potential biochemical markers of ischemic stroke and can be used for predicting the onset of acute ischemic stroke. As these are easily available investigations, further study has to be done comparing the ischemic and hemorrhagic parameters to predict the onset and prognosis of cerebrovascular accidents.

**Conflict of Interest:** Authors have declared that no competing interests exist.

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