Altered CBC indices among hypertensives-a cross-sectional study

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Abstract- Hypertension remains the most common and most important factor for development of cardiovascular diseases. Uncontrolled hypertension can lead to numerous vascular complications. There are multiple factors leading to the development of hypertension out of which White Blood Cell(WBC) count and other mediators of inflammation are said to play a very important role in development of cardiovascular diseases.

Aim- In this study, we aim to evaluate the alterations in CBC indices in hypertensive patients by comparing them with a normotensive population.

Method- A cross-sectional study was carried out among patients who were known cases of hypertension, attending the out-patient department during the month of January 2023. Total of 318 subjects were included in this study. 159 hypertensive patients and 159 normotensive subjects were selected for the study.

Result- The RBC parameters of hypertensive(HT) patients showed significant difference compared to the normotensive(NT) population. Both WBC count and Neutrophil-lymphocyte Ratio(NLR) were found to be significantly higher in the hypertensive population. Platelet parameters of hypertensive patients did not show a significant difference as compared to the normotensive population.

Conclusion- The present study shows the alteration in hematological parameters among hypertensives. RBC parameters have been found to be significantly reduced in hypertensives while plateletcrit,total WBC count and Neutrophil-Lymphocyte Ratio have been found to be increased in hypertensives. This is in concordance with other studies that shows elevated WBC count with neutrophilia and platelet parameters as an important prognostic indicator in hypertension, highlighting the need for close monitoring of various CBC parameters among hypertensives.

Keywords- Hypertension, Complete Blood Count, Neutrophil-Lymphocyte Ratio

I. INTRODUCTION
Hypertension remains the most common and most important factor for development of cardiovascular diseases. According to National Family Health Survey Series 5(2019-2021), the prevalence of hypertension in India was 21 % in females and 24% in males.\(^{(1)}\) This is higher than the previous survey (NFHSS 4) that showed a prevalence of 18.1%.\(^{(2)}\) Hypertension has been increasing in prevalence as the average life expectancy has increased along with other contributing factors such as leading a sedentary lifestyle and having an unhealthy diet with poor sleep patterns.

According to World health Organisation (WHO), a patient is said to be hypertensive if, on two different days, the blood pressure values recorded are more than or equal to 140/90 mmHg.\(^{(3)}\) An increase in blood pressure alters the hematological parameters and can lead to a range of functional disturbances when left untreated.

Uncontrolled hypertension can lead to numerous vascular complications including stroke, coronary artery disease, and even death.\(^{(4)}\) There are multiple factors leading to the development of hypertension out of which White Blood Cell (WBC) count and other mediators of inflammation are said to play a very important role in development of cardiovascular diseases.\(^{(5)}\) Evaluation of Complete Blood Count (CBC) values can provide information about the general health status of the patient. Elevated or altered CBC values like platelet parameters, Hemoglobin (Hb), hematocrit (HCT) and WBC count have been reported to be associated with poor outcomes or the development of cardiovascular diseases in hypertensives.\(^{(6,7,8)}\)

In this study, we aim to evaluate the alterations in CBC indices in hypertensive patients by comparing them with a normotensive population. This could provide an insight into the role of these altered parameters in development of vascular complications and emphasize the need for close monitoring of the various hematological parameters in patients with uncontrolled hypertension.

II. MATERIALS AND METHOD
Study area: The study was conducted in Kerala, India.

Study design and study period: A cross-sectional study was carried out among patients who were known cases of hypertension, attending the out-patient department during the month of January 2023.

Sample size:
Sample size was calculated using the following formula:
\[
N = \left(\frac{Z_{\alpha/2} \times \sigma}{\delta}\right)^2
\]

Where \(Z_{\alpha/2}\)=Critical value at 5% level of significance (1.96)
Total of 318 subjects were included in this study. 159 hypertensive patients were evaluated and CBC findings were tabulated. 159 subjects were selected from the normotensive population after being age and sex-adjusted. 96 females and 63 males were included in both group.

**Inclusion criteria:** Patients who were known cases of hypertension were included in the study.

**Exclusion criteria:** Patients with diabetes mellitus, malignancies and liver diseases were excluded from this study.

**Study protocol:** Blood samples were sent to be processed and evaluated by Auriba ABX Penta xlr hematology analyser. CBC findings were obtained and peripheral smears were prepared and evaluated.

Data analysis: Data was entered and tabulated in Microsoft Excel and analysis was carried out by SPSS software (version 16.0).

### III. RESULTS

Out of 159 hypertensive patients, 96 patients were females and 63 were males. Normotensive group was also selected with 96 females and 63 males after being age-adjusted. The gender distribution of the group is depicted in figure 1.

Figure 1: Sex distribution of the hypertensive population

Ages of the patients ranged from 42 to 98 years.

Age distributions of the patients are shown in Table 1 and figure 2

<table>
<thead>
<tr>
<th>Age group</th>
<th>Male</th>
<th>Female</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤50 years</td>
<td>3</td>
<td>4</td>
<td>7</td>
</tr>
<tr>
<td>51-70 years</td>
<td>26</td>
<td>47</td>
<td>73</td>
</tr>
<tr>
<td>71-90 years</td>
<td>34</td>
<td>43</td>
<td>77</td>
</tr>
<tr>
<td>&gt;90 years</td>
<td>0</td>
<td>2</td>
<td>2</td>
</tr>
</tbody>
</table>

Table 1: Age distribution of the hypertensive population
RBC parameters:
The RBC parameters of hypertensive (HT) patients showed significant difference compared to the normotensive (NT) population. The RBC parameters were as follows:
The RBC parameters of both populations are tabulated in Table 2

Table 2: RBC parameters of the study population

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Mean</th>
<th>Standard deviation</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hb of HT patients (g/dl)</td>
<td>9.07673</td>
<td>2.346346</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Hb of NT population (g/dl)</td>
<td>12.33145</td>
<td>2.118966</td>
<td></td>
</tr>
<tr>
<td>RBC count of HT patients (x10^6/mm³)</td>
<td>3.313711</td>
<td>0.846185</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>RBC count of NT population (x10^6/mm³)</td>
<td>4.179623</td>
<td>0.654604</td>
<td></td>
</tr>
<tr>
<td>HCT of HT patients (%)</td>
<td>27.35283</td>
<td>6.694716</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>HCT of NT population (%)</td>
<td>35.73966</td>
<td>5.516314</td>
<td></td>
</tr>
<tr>
<td>MCV of HT patients (µm³)</td>
<td>83.06289</td>
<td>7.999751</td>
<td>=0.001</td>
</tr>
<tr>
<td>MCV of NT population (µm³)</td>
<td>85.83648</td>
<td>7.227649</td>
<td></td>
</tr>
<tr>
<td>MCH of HT patients (pg)</td>
<td>27.53836</td>
<td>3.216055</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>MCH of NT population (pg)</td>
<td>29.54906</td>
<td>2.902397</td>
<td></td>
</tr>
<tr>
<td>MCHC of HT patients (g/dl)</td>
<td>33.11698</td>
<td>1.894102</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>MCHC of NT population (g/dl)</td>
<td>34.44025</td>
<td>2.095478</td>
<td></td>
</tr>
<tr>
<td>RDW-CV of HT patients (%)</td>
<td>13.46918</td>
<td>1.899665</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>
The Hb value of hypertensive patients varied from 4 g/dl to 16.7 g/dl whereas in the normotensive population, values ranged from 5.9 g/dl to 16.4 g/dl. The majority of cases from the hypertensive group were diagnosed as Normocytic normochromic anemia (72 cases). Out of these, 12 cases showed presence of microcytic cells. 30 cases were reported as Microcytic hypochromic anemia. 6 cases were reported as dimorphic anemia. 2 cases showed evidence of hemolysis and one case showed a leukoerythroblastic blood picture. The rest of the cases were reported as peripheral smear within normal limits. The hypertensive population showed significant anisopoiikilocytosis compared to the normotensive population. More than 90% smears from the normotensive population showed normocytic normochromic cells. Occasional dimorphic pictures of normocytic cells and microcytes were seen.

Red Blood Cell (RBC) count of hypertensive patients ranged from 1.42 x10⁶/mm³ to 6.58 x10⁶/mm³, while the normotensive population showed values ranging from 2.34 x10⁶/mm³ to 6.33 x10⁶/mm³. HCT of the hypertensive subjects varied from 10.5% to 50.7% with a mean value of 27.3%. HCT of the normotensive population ranged from 19.3% to 47.3% with a mean value of 35.5%.

Mean Cell Volume (MCV) of the hypertensive subjects varied from 61 µm³ to 101 µm³ with a mean value of 83.06 µm³. MCV of the normotensive population ranged from 61 µm³ to 105 µm³ with a mean value of 85.4 µm³. Mean Corpuscular Hemoglobin (MCH) of the hypertensive subjects varied from 17.3 pg to 35.4 pg with a mean value of 27.5 pg. MCH of the normotensive population ranged from 19.4 pg to 38.1 pg with a mean value of 29.3 pg. Mean Corpuscular Hemoglobin Concentration (MCHC) of the hypertensive subjects varied from 25.8 g/dl to 42.3 g/dl with a mean value of 33.11 g/dl. MCHC of the normotensive population ranged from 29.5 g/dl to 46.6 g/dl with a mean value of 34.3 g/dl. RDW-CV of the normotensive subjects varied from 10.5 % to 22.4 % with a mean value of 13.4 %. RDW-CV of the non-diabetic population ranged from 10.5 % to 17.7 % with a mean value of 12.7 %. RDW-SD of hypertensive cases ranged from 29 µm³ to 56 µm³, whereas normotensive population showed values ranging from 30 µm³ to 51 µm³.

**Platelet parameters:**
Platelet parameters of hypertensive patients did not show a difference of statistical significance as compared to the normotensive population. The parameters were as follows:
The platelet parameters from both the populations are tabulated in Table 3

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Mean</th>
<th>Standard deviation</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Platelet count of HT patients (x10⁶/mm³)</td>
<td>2.675346</td>
<td>1.506604</td>
<td>&gt;0.05</td>
</tr>
<tr>
<td>Platelet count of NT population (x10⁶/mm³)</td>
<td>2.531698</td>
<td>0.992381</td>
<td></td>
</tr>
<tr>
<td>MPV of HT patients (µm³)</td>
<td>8.12327</td>
<td>1.19202</td>
<td>&gt;0.05</td>
</tr>
<tr>
<td>MPV of NT population (µm³)</td>
<td>8.050314</td>
<td>0.961925</td>
<td></td>
</tr>
<tr>
<td>PCT of HT patients (%)</td>
<td>0.224107</td>
<td>0.150178</td>
<td>=0.05</td>
</tr>
<tr>
<td>PCT of NT population (%)</td>
<td>0.198742</td>
<td>0.070091</td>
<td></td>
</tr>
<tr>
<td>PDW of HT patients (%)</td>
<td>14.16013</td>
<td>3.853213</td>
<td>&gt;0.05</td>
</tr>
<tr>
<td>PDW of NT population (%)</td>
<td>13.42595</td>
<td>3.073747</td>
<td></td>
</tr>
</tbody>
</table>

**Abbreviations:** MPV: Mean Platelet Volume, PCT: Plateletcrit, PDW: Platelet Distribution Width
Plateletcrit values of hypertensive patients ranged from 0.01% to 1.1%, whereas the normal population showed values ranging from 0.009 % to 0.4 %. A p-value of 0.05 were obtained for this parameter proving its statistical significance. All other values showed no statistical significance.

WBC parameters:
WBC parameters were as follows:
WBC counts of the hypertensive patients varied from 2.3 x10³/mm³ to 51.8 x10³/mm³ with a mean value of 11.18 x10³/mm³. WBC counts of the normotensive population ranged from 3.6 x10³/mm³ to 31 x10³/mm³ with a mean value of 7.84 x10³/mm³. Neutrophil-Lymphocyte Ratio (NLR) of the hypertensive patients varied from 0.16 to 47 with a mean value of 6.32. NLR of the normotensive population ranged from 0.75 to 15.66 with a mean value of 3.00. Both WBC count and NLR were found to be significantly higher in the hypertensive population.

The findings from both populations are tabulated in Table 4

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Mean</th>
<th>Standard deviation</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total WBC count of HT patients (x10⁵/mm³)</td>
<td>11.18679</td>
<td>6.652725</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Total WBC count of NT population (x10⁵/mm³)</td>
<td>7.849686</td>
<td>2.951954</td>
<td></td>
</tr>
<tr>
<td>NLR of HT patients</td>
<td>6.328463</td>
<td>6.743266</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>NLR of NT population</td>
<td>3.009621</td>
<td>2.796095</td>
<td></td>
</tr>
</tbody>
</table>

Abbreviations: WBC: White Blood Cell; NLR: Neutrophil Lymphocyte Ratio

IV. DISCUSSION
Hypertension is a major public health problem in developing countries. As the prevalence of hypertension is increasing along with hypertension related cardiovascular diseases, there arises a need for early identification of at-risk patients and timely intervention with monitoring.

This study showed that all the RBC parameters were significantly altered in hypertensives with a reduction in values of Hemoglobin, RBC count, HCT, MCV, MCH and MCHC. RDW-CV and RDW-SD was raised in hypertensives, indicating the anisopoikilocytosis seen in hypertensives. Studies conducted by Reis RS et al(9), R Divya and V Ashok(10), Al-Muhana F A et al(11) showed similar decrease in Hb and HCT values whereas in the study conducted by Beza Sileshi et al(12), median values of Hb, HCT and RDW were significantly higher in the hypertensive group.

It has been reported that increased Hb and HCT indicate increased viscosity leading to the occurrence of cardiovascular diseases. (13) However, this relation has not been established. In the study conducted by Osaro Erhabor et al(14) the mean value for Hb was shown to be lower among hypertensives, Study conducted by Beza Sileshi et al was in concordance with our finding of increased RDW in the hypertensive population. (12) Osaro Erhabor et al(14) also proved that RDW was not significantly altered among hypertensives while Sahin I et al showed significantly higher RDW values among hypertensives. (15) Reduced MCV values were observed in hypertensive subjects compared with normotensive subjects, similar to the study conducted by Elendu et al. (16) However, studies conducted by Haltmayer M et al(17) and Karabulut A et al (18) showed no significant c relationship between MCV and hypertension. The present study showed no significant change in platelet parameters among hypertensives except plateletcrit which was significantly higher in hypertensive group.

The study conducted by Osaro Erhabor et al(19) and Formal M et al(20) showed no significant difference in platelet parameters among hypertensive and normotensive individuals. The correlation between platelet indices and hypertension induced organ damage has been reported in previous studies. (20, 21, 22, 23) The study conducted by Beza Sileshi et al (12) showed higher MPV values among hypertensives, which was in concordance with the study conducted by Enawgaw et al (24).

The present study shows a higher Total WBC count and Neutrophil Lymphocyte Ratio among hypertensive as compared to the normotensive population. This is similar to the findings of the study conducted by Beza Sileshi et al (12), Enawgaw et al (24), Al Muhana et al(11) and Babu et al. (25)

Studies conducted by M U Elendu et al (16), Shankar A et al (26), Nakamishi N et al (27), Gillum R F et al. (28), Karthikeyan V J et al (29) and Orakzai RH et al (30) showed an increase in WBC count with predominant neutrophilia among hypertensives. Studies done by Reis et al (30) and Divya et al (31) showed no statistically significant difference in WBC count although the study conducted by Osaro Erhabor et al (14) showed WBC count to be significantly lower among hypertensives. WBC count is a marker of inflammation and has been reported to be an independent predictor of cardiovascular disease in several studies. (31, 32, 33) Neutrophil count has been found to be markedly increased and linked with increased blood pressure. (34)
In concordance with other studies, parameters like plateletcrit and NLR are significantly altered in hypertensives. Further studies are warranted in this field as this study is limited due to the fact that it is a cross-sectional study and prognostic follow-up could not be assessed.

V. CONCLUSION
The present study shows the alteration in hematological parameters among hypertensives. RBC parameters have been found to be significantly reduced in hypertensives while plateletcrit, total WBC count and Neutrophil-Lymphocyte Ratio have been found to be increased in hypertensives. This is in concordance with other studies that shows elevated WBC count with neutrophilia and platelet parameters as an important prognostic indicator in hypertension. This study further highlights the need for close monitoring of various CBC parameters among hypertensives.

VI. CONFLICTS OF INTEREST:
None

VII. FUNDING:
None

REFERENCES: