

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:

$$N = \frac{(Z_{\alpha/2} + 2\beta)^2 \times 2\sigma^2}{d^2}$$

d^2

Where $Z_{\alpha/2}$ = Critical value at 5% level of significance (1.96)

2β =critical value at 80% power (0.84)
 σ =pooled standard deviation (1.8)
 d=mean difference (0.6)

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.

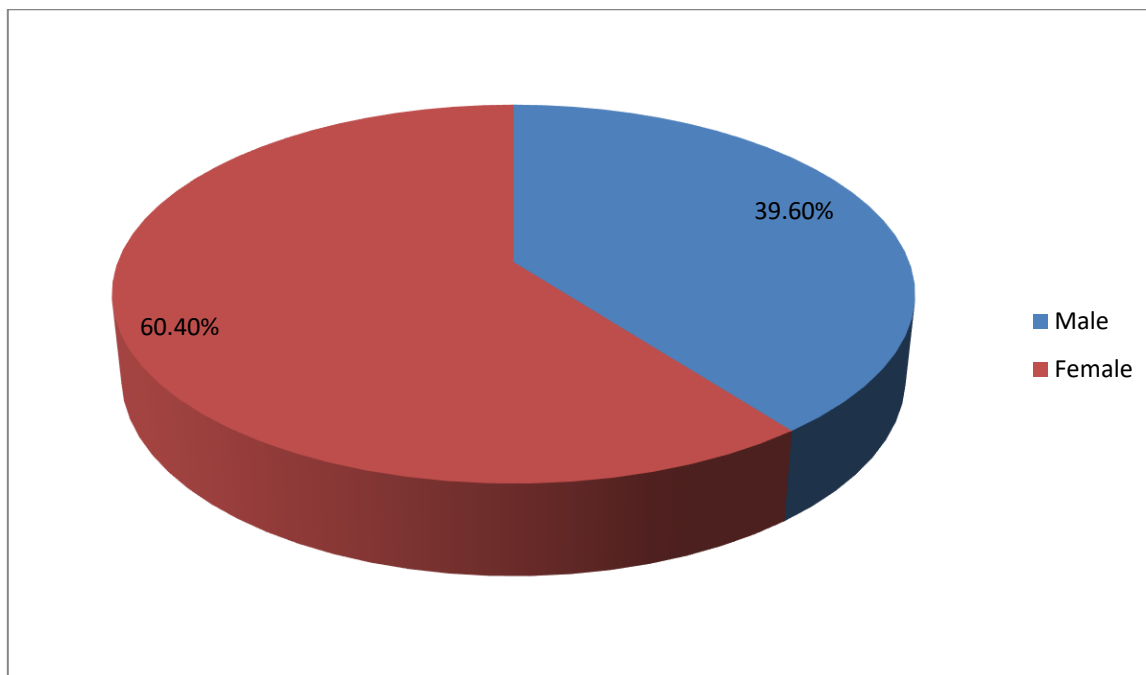
Study protocol: Blood samples were sent to be processed and evaluated by Auriba ABX Penta xlr hematology analyser. CBC findings were obtained and peripheral smears were prepared and evaluated.

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



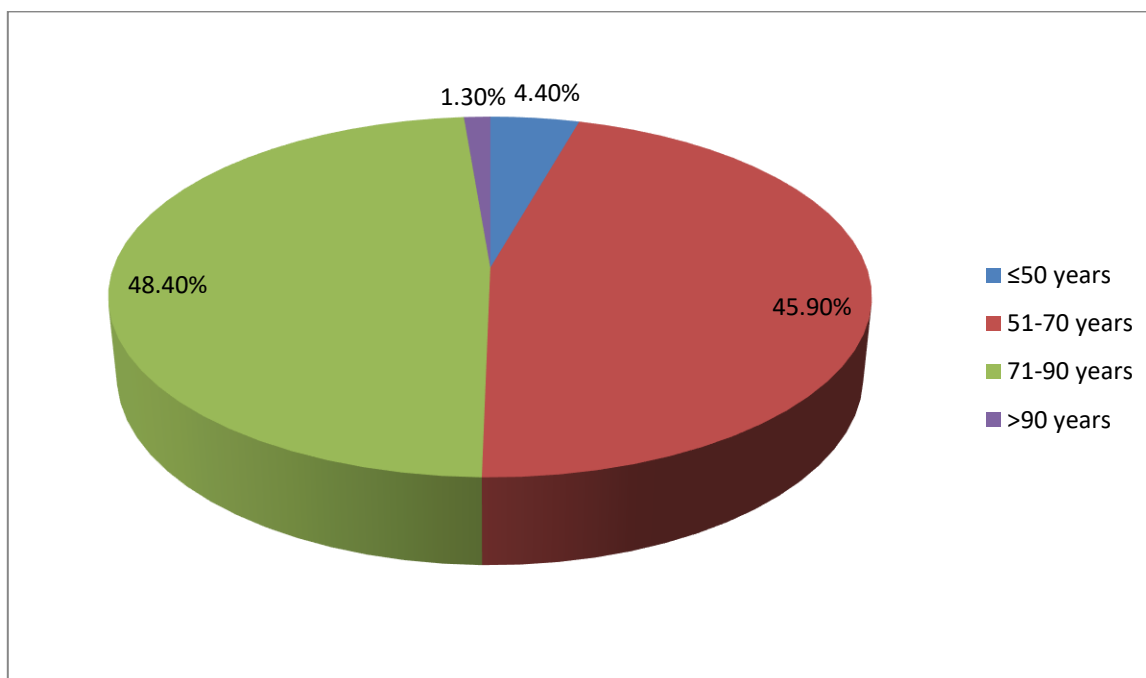
Ages of the patients ranged from 42 to 98 years.

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

Table 1: Age distribution of the hypertensive population

Age group	Male	Female	Total
≤50 years	3	4	7
51-70 years	26	47	73
71-90 years	34	43	77
>90 years	0	2	2

Figure 2: Age distribution of the study 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

Parameters	Mean	Standard deviation	p-value
Hb of HT patients(g/dl)	9.07673	2.346346	<0.001
Hb of NT population(g/dl)	12.33145	2.118966	
RBC count of HT patients(x10⁶/mm³)	3.313711	0.846185	<0.001
RBC count of NT population(x10⁶/mm³)	4.179623	0.654604	
HCT of HT patients(%)	27.35283	6.694716	<0.001
HCT of NT population(%)	35.73396	5.516314	
MCV of HT patients(μm³)	83.06289	7.999751	=0.001
MCV of NT population(μm³)	85.83648	7.227649	
MCH of HT patients(pg)	27.53836	3.216055	<0.001
MCH of NT population(pg)	29.54906	2.902397	
MCHC of HT patients(g/dl)	33.11698	1.894102	<0.001
MCHC of NT population(g/dl)	34.44025	2.095478	
RDW-CV of HT patients(%)	13.46918	1.899665	<0.001

RDW-CV of NT population(%)	12.63648	1.259064	
RDW-SD of HT patients(μm^3)	39.84906	4.563461	<0.05
RDW-SD of NT population (μm^3)	38.80503	3.463148	

Abbreviations: Hb:Hemoglobin, RBC: Red Blood Cell, HCT: Hematocrit, MCV: Mean Corpuscular Volume, MCH: Mean Corpuscular Hemoglobin, MCHC: Mean Corpuscular Hemoglobin Concentration, RDW-CV : Red Cell Distribution Width – Coefficient of variation, RDW-SD :Red Cell Distribution Width- Standard Deviation; HT: Hypertensive; NT: Normotensive

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 anisopoikilocytosis 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 $1.42 \times 10^6/\text{mm}^3$ to $6.58 \times 10^6/\text{mm}^3$, while the normotensive population showed values ranging from $2.34 \times 10^6/\text{mm}^3$ to $6.33 \times 10^6/\text{mm}^3$.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 $61 \mu\text{m}^3$ to $101 \mu\text{m}^3$ with a mean value of $83.06 \mu\text{m}^3$.MCV of the normotensive population ranged from $61 \mu\text{m}^3$ to $105 \mu\text{m}^3$ with a mean value of $85.4 \mu\text{m}^3$.

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 $29 \mu\text{m}^3$ to $56 \mu\text{m}^3$, whereas normotensive population showed values ranging from $30 \mu\text{m}^3$ to $51 \mu\text{m}^3$.

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 3: Platelet parameters of the study population

Parameters	Mean	Standard deviation	p-value
Platelet count of HT patients ($\times 10^5/\text{mm}^3$)	2.675346	1.506604	>0.05
Platelet count of NT population($\times 10^5/\text{mm}^3$)	2.531698	0.992381	
MPV of HT patients(μm^3)	8.12327	1.19202	>0.05
MPV of NT population(μm^3)	8.050314	0.961925	
PCT of HT patients (%)	0.224107	0.150178	=0.05
PCT of NT population (%)	0.198742	0.070091	
PDW of HT patients (%)	14.16013	3.853213	>0.05
PDW of NT population (%)	13.42595	3.073747	

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 $2.3 \times 10^3/\text{mm}^3$ to $51.8 \times 10^3/\text{mm}^3$ with a mean value of $11.18 \times 10^3/\text{mm}^3$. WBC counts of the normotensive population ranged from $3.6 \times 10^3/\text{mm}^3$ to $31 \times 10^3/\text{mm}^3$ with a mean value of $7.84 \times 10^3/\text{mm}^3$.

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 4: WBC parameters of the study population

Parameters	Mean	Standard deviation	p-value
Total WBC count of HT patients($\times 10^3/\text{mm}^3$)	11.18679	6.652725	<0.001
Total WBC count of NT population($\times 10^3/\text{mm}^3$)	7.849686	2.951954	
NLR of HT patients	6.328463	6.743266	<0.001
NLR of NT population	3.009621	2.796095	

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 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⁽¹⁴⁾ and Fornal M et al⁽¹⁹⁾ 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⁾ Nakanishi 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⁽⁹⁾ and Divya et al⁽¹⁰⁾ 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

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