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Research Article

RED CELL DISTRIBUTION WIDTH – AN IGNORED BUT EMERGING INDICATOR TO PREDICT ADVERSE EVENTS IN HYPERTENSIVE PATIENTS

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ABSTRACT

Objectives: Hypertension (HT) is related to the development of ischemic heart disease, heart failure, stroke, and chronic kidney disease. It is one of the primary causes of long-term morbidity and mortality. Past studies showed that red blood cell (RBC) morphology plays a significant role in inflammatory conditions of HT. Hence, this study was conducted to find association of erythrocyte parameters like RBC distribution width (RDW) with arterial blood pressure in hypertensives.

Methods: The study was conducted in two groups: study and control. Fifty hypertensives and 50 normotensives between 40 and 60 years, matching inclusion and exclusion criteria were involved, and blood samples were taken and analyzed.

Results: Our study has found significantly low values of mean corpuscular volume and mean corpuscular hemoglobin in the study group. However, the study group shows significantly high RDW values as compared to control group.

Conclusion: High RDW values in hypertensives are a strong indicator of RBC abnormality, and it is associated with various vascular complications along with end-organ damage.

Keywords: Erythrocyte, Red blood cell indices, Red blood cell distribution width value, Hypertension.

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INTRODUCTION

Arterial hypertension (HT) is the major health disorder that affects high number of adult population and it is one of the leading causes of death in the community. It comes with uncertain etiology, pathophysiology, and clinical complications like coronary heart disease and stroke [1]. Due to rapid environmental and "lifestyle" changes, the burden of HT is expected to increase in the coming years [2]. More than 60% of overall deaths are due to non-communicable diseases, and out of all nearly half of them are due to cardiovascular diseases (CVDs). High blood pressure is the most important risk factor for CVDs, and it is related to long-term damage to vital organs of our body. HT is the primary cause of death in patients of coronary artery disease and stroke [3,4].

Plasma and whole blood viscosity are two important factors of arterial BP, and it play a role in the development of CVDs. Past studies have shown that change in mean corpuscular volume (MCV) can alter metabolic conditions, which can be one of the cause of arterial stiffness [5,6]. Abnormality of red blood cell (RBC) can lead to dysfunction of narrow blood vessels in HT, and recent studies have reported association of RBC distribution width (RDW) is a measure of the variation of RBC size that can predict early onset of cardiovascular and cerebrovascular disease [7-9]. Furthermore, previous studies have shown role of hemoglobin in the development of HT and many diseases associated with it [10,11].

In the present study, we have used RBC count, hemoglobin (Hb) concentration, and packed cell volume (PCV) values as indirect measurement of blood viscosity. Moreover, we explored the association of RBC hematological parameters such as PCV, MCV, mean corpuscular hemoglobin (MCH), mean corpuscular hemoglobin concentration (MCHC), and RDW with arterial blood pressure in hypertensives.

METHODS

The study was approved by the Institutional Ethical Committee of the Government Medical College of Surat, and written informed consent was obtained from each participant. This study was conducted in two groups: study and control. In the study group, 50 hypertensive patients aged 40–60 years, males and females with a history of HT (>1 year duration), or taking anti-hypertensive medications with blood pressure systolic BP more than 140 mm Hg, Diastolic BP more than 90 mmHg were taken from medicine outpatient clinics, New Civil Hospital Surat. In the control group, 50 normotensives aged 40–60 years, males and females with systolic BP <140 mmHg, Diastolic BP <90 mmHg were taken, who were matched socio-economically with the study group. All systemic diseases other than HT and patients with present illness were excluded from the study [12].

The physiological parameters height, weight, pulse rate, and blood pressure along with detailed history were taken. In the sitting position, after 5 min of rest, BP was measured through auscultatory method using sphygmomanometer (mercury manometer) in both the arms. Higher of the two readings was taken and if systolic blood pressure (SBP) and diastolic blood pressure (DBP) were in different categories, the higher of 2 was classified. Under aseptic precautions, venous blood samples (3 mL) were collected in EDTA vaccutte from median cubital vein, and analyzed by ABX MICROS 60.

Mean arterial blood pressure was calculated, and values of RBC count, Hb concentration, PCV, MCV, MCH, MCHC, and RDW were taken from CBC reports. Unpaired t-test was used to compare the data, and p value was used to decide the significance level. ($p<0.05$ significant, $p<0.01$ highly significant). In the study group, the correlation between blood pressure and PCV, MCV, MCH, MCHC, and RDW was found by calculating Pearson's correlation factor (r). Statistical analyses were performed in SPSS software.

RESULTS

Table 1 shows the comparison of age, height, and weight between the two groups was not statistically significant (p>0.05). Both groups were comparable to each other. Moreover, significantly high SBP, DBP and mean arterial pressure (MAP) in the study group.

Table 2 shows the comparison of RBC count, Hb concentration, PCV, MCV, MCH, MCHC, and RDW between study and control groups. MCV and MCH values are lower in study group which is statistically significant (p<0.05). RDW value is significantly high in the study group as compared to the control group.

Table 3 shows correlation of SBP, DBP, and MAP with RBC count, Hb, PCV, MCV, MCH, MCHC, and RDW in the study group. Hb, PCV, MCV, MCH, and MCHC positively associated with SBP, DBP and MAP. However, RBC count and RDW negatively associated with SBP, DBP and MAP.

DISCUSSION

This study was conducted in two groups: a study group and a control group. Fifty hypertensives and 50 normotensives were taken as the study and control group, respectively. Both groups were comparable to each other as age, height, and weight are not statistically significant, and the study group shows significantly high SBP, DBP, and MAP (Table 1). Our study shows significantly lower MCV and MCH values in the study group as compared to the control group. However, RDW values significantly higher in the study group (Table 2). Furthermore, we found a positive correlation between SBP, DBP, and MAP with hemoglobin concentration, PCV, MCV, MCH, and MCHC, and a negative correlation with RBC count and RDW in the study group (Table 3).

Table 1: Comparison of age, height, weight, SBP, DBP, and MAP between study and control groups

	Study group	Control group	p value
	Mean±SD	Mean±SD	
Age	48.88±7.18	47.84±7.04	>0.05
Height	154.16±7.64	153.8±8.77	>0.05
Weight	67.78±10.58	65.34±6.72	>0.05
SBP	146.24±6.53	119.16±3.43	<0.01
DBP	91.56±1.95	78.4±2.09	<0.01
MAP	109.79±3.27	91.98±2.31	<0.01

SBP: Systolic blood pressure, DBP: Diastolic blood pressure, MAP: Mean arterial pressure

Table 2: RBC count, Hb concentration, PCV, MCV, MCH, MCHC, and RDW in study and control group

	Study group	Control group	p value
	Mean±SD	Mean±SD	
RBC count	4.59±0.67	4.45±0.75	>0.05
Hb	12.47±1.77	12.75±1.78	>0.05
PCV	39.58±5.10	40.61±5.80	>0.05
MCV	86.89±9.27	92.62±14.36	<0.05
MCH	27.46±3.61	29.21±5.12	<0.05
MCHC	31.15±3.34	31.12±3.43	>0.05
RDW	14.36±1.45	13.76±1.30	<0.05

RBC: Red blood cell, Hb: Hemoglobin, PCV: Packed cell volume, MCV: Mean corpuscular volume, MCH, Mean corpuscular hemoglobin, MCHC: Mean corpuscular hemoglobin concentration, RDW: Red blood cell distribution width

Table 3: Correlation of SBP, DBP, and MAP with in RBC count, Hb concentration, PCV, MCV, MCH, MCHC, and RDW study group

		RBC count	Hb	PCV	MCV	MCH	MCHC	RDW
SBP	r	−0.014	0.151	0.025	0.038	0.151	0.238	−0.114
DBP	r	−0.023	0.259	0.100	0.129	0.265	0.317	−0.086
MAP	r	−0.018	0.204	0.056	0.077	0.206	0.284	−0.110

RBC: Red blood cell, Hb: Hemoglobin, PCV: Packed cell volume, MCV: Mean corpuscular volume, MCH, Mean corpuscular hemoglobin, MCHC: Mean corpuscular hemoglobin concentration, RDW: Red blood cell distribution width

Population-based past studies have shown positive relation of SBP and DBP with RBC count, Hb concentration, and MCV. We also found similar results but in our study, RBC count shown a negative correlation with SBP, DBP, and MAP (Table 3) [13,14]. A study by Devereux *et al*. has shown high whole blood viscosity among untreated hypertensives than normotensives, but have not shown any relationship between PCV and whole blood viscosity. This study is in accordance to our study as we have not found statistically significant PCV values among two groups (Table 2) [15]. However, Cirillo *et al*. have shown significantly higher PCV value in hypertensives than normotensives, that suggestive of increase in whole blood viscosity and development of high blood pressure [16]. A large cohort study was conducted by Atsma *et al*. demonstrated a positive association of Hb concentration with arterial blood pressure in men and women. This study favors our study as we have found similar results, but we have not found any significant change in Hb concentrations between two groups (Table 2) [10]. We have reported significantly lower MCV and MCH values (Table 2) that is in accordance with the study by Ali and Yasmeen that have shown similar findings among patients of primary hypertensives as compare to normotensives [17].

The present study shows significantly higher RDW values in hypertensives as compared to normotensives (Table 2) which is in accordance with the study of Seo *et al*. who mention that high RDW was associated with higher risk of adverse eventin HT [18]. Similar results have been noted by Tsuda, and they have mentioned that RBC could synthesize NO and alter functions of blood vessels. Furthermore, they have reported that lower membrane fluidity of RBCs was associated with decreased levels of plasma NO metabolite [7]. A study by Karabulut and Karadag has concluded that RDW reflect oxidative stress and activity of different neurohormonal and inflammatory mechanisms that are associated with development of HT and vascular complications and it is also linked to end-organ damage [1].

In this study, we have reported significantly low MCV and MCH values that suggestive of RBC and Hb are actively participating in the development of HT and its adverse events. In addition to this, we found significantly high RDW values in hypertensives which is a strong indicator that abnormality in RBC is associated with various vascular complications and end-organ damage in hypertensives. Although we have explored association of different erythrocyte parameters in hypertensives, a planned study is required that includes a large number of participants on a broader scale.

CONCLUSION

RBC is actively participating in the development of HT that was shown by erythrocyte indices. High RDW values in hypertensives are a strong indicator of RBC abnormality, and it is associated with various vascular complications along with end organ-damage.

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CONFLICTS OF INTERESTS

None.

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REFERENCES

1. Karabulut A, Karadag A. Clinical implication of hematological indices in the essential hypertension. World J Hypertens 2015;5:93-7. doi: 10.5494/wjh.v5.i2.93

2. Ghosh S, Kumar M. Prevalence and associated risk factors of hypertension among persons aged 15-49 in India: A cross-sectional study. BMJ Open 2019;9:e029714. doi: 10.1136/bmjopen-2019-029714, PMID 31848161
3. Hypertension. Available from: https://www.who.int/india/health-topics/hypertension
4. Ramakrishnan S, Zachariah G, Gupta K, Shivkumar Rao J, Mohanan PP, Venugopal K, *et al*. Prevalence of hypertension among Indian adults: Results from the great India blood pressure survey. Indian Heart J 2019;71:309-13. doi: 10.1016/j.ihj.2019.09.012, PMID 31779858
5. Jacob PR, Sally MK, John BE, Frank BM, Sampson A, Francesco PC. Blood pressure and haematological indices in twelve communities in Ashanti, Ghana. Int J Hypertens 2018;2018:5952021.
6. Kwon H, Park B. Borderline-high mean corpuscular volume levels are associated with arterial stiffness among the apparently healthy Korean individuals. Korean J Fam Med 2020;41:387-91. doi: 10.4082/kjfm.19.0061, PMID 31955550
7. Tsuda K. Red blood cell abnormalities and hypertension. Hypertens Res 2020;43:72-3. doi: 10.1038/s41440-019-0353-0, PMID 31666713
8. Li N, Zhou H, Tang Q. Red blood cell distribution width: A novel predictive indicator for cardiovascular and cerebrovascular diseases. Dis Markers 2017;2017:7089493. doi: 10.1155/2017/7089493, PMID 29038615
9. Danese E, Lippi G, Montagnana M. Red blood cell distribution width and cardiovascular diseases. J Thorac Dis 2015;7:E402-11. doi: 10.3978/j.issn.2072-1439.2015.10.04, PMID 26623117
10. Atsma F, Veldhuizen I, De Kort W, Van Kraaij M, Pasker-de Jong P, Deinum J. Hemoglobin level is positively associated with blood pressure in a large cohort of healthy individuals. Hypertension 2012;60:936-41. doi: 10.1161/HYPERTENSIONAHA.112.193565, PMID 22949533
11. Lee SG, Rim JH, Kim JH. Association on of haemoglobin levels with blood pressure and hypertension in a large population-based study: The Korea national health and nutrition examination surveys 2008-2011. Clin Chim Acta 2015;438:12-8.
12. Sunbul M, Gerin F, Durmus E, Kivrak T, Sari I, Tigen K, *et al*. Neutrophil to lymphocyte and platelet to lymphocyte ratio in patients with dipper versus non-dipper hypertension. Clin Exp Hypertens 2013;36:217-21.
13. McDonough JR, Hames CG, Garrison GE, Stulb SC, Lichtman MA, Hefelfinger DC. The relationship of hematocrit to cardiovascular states of health in the Negro and white population of Evans County. Georgia. J Chron Dis 1965;18:243-57. doi: 10.1016/0021-9681(65)90151-7, PMID 14278160
14. Bao W, Dalferes ER, Srinivasan SR, Webber LS, Berenson GS. Normative distribution of complete blood count from early childhood through adolescence: The Bogalusa heart study. Prev Med 1993;22:825-37. doi: 10.1006/pmed.1993.1075, PMID 8115341
15. Devereux RB, Case DB, Alderman MH, Pickering TG, Chien S, Laragh JH. Possible role of increased blood viscosity in the hemodynamics of systemic hypertension. Am J Cardiol 2000;85:1265-8. doi: 10.1016/s0002-9149(00)00744-x, PMID 10802017
16. Cirillo M, Laurenzi M, Trevisan M, Stamler J. Hematocrit, blood pressure, and hypertension. The Gubbio population study. Hypertension 1992;20:319-26. doi: 10.1161/01.hyp.20.3.319, PMID 1516951
17. Ali I, Yasmeen N. A comparative study of hematological parameters in normal and hypertensive individuals. Int J Physiol 2017;5:35-40. doi: 10.5958/2320-608X.2017.00008.7
18. Seo SG, Lee MY, Park SH, Han JM, Lee KB, Kim H, *et al*. The association between red cell distribution width and incident hypertension in Korean adults. Hypertens Res 2020;43:55-61. doi: 10.1038/s41440-019-0334-3, PMID 31551565