Original Article

Comparison of Red Cell Indices between Hypertensive and Normotensive Individual in Rajshahi City

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Abstract

Background: *Hypertension is a major public health problem worldwide. Hypertension is a risk factor for stroke, renal failure and cardiovascular disease and has an impact on hematological parameters. Hypertension with abnormal hematological parameters enhance end-organ damage. The aim of this study was to explore whether red cell indices parameters (MCV, MCH and MCHC) were associated with hypertension or not.* ***Materials and Methods:*** *This cross-sectional comparative study was carried out in the Department of Physiology in collaboration with OPD Department of Medicine in Rajshahi Medical College from January 2019 to December 2019 among the hypertensive patients and normal adults in Rajshahi city with ethical clearance from respective IERB. Samples were collected by purposive sampling technique. Pre-designed, validated, structured questionnaire was used to gather information from 60 hypertensive and 60 normotensive respondents residing in Rajshahi City. In both group, gender ratio was equal. Unpaired 't' test was performed to compare the red cell indices between two groups. Data were analyzed by SPSS software, version-24. A p-value <0.05 was considered statistically significant.* ***Results:*** *In hypertensive group, more than half (53.3%) of the respondents had systolic blood pressure between 140 to 159 mmHg and less than three-quarter (73.3%) had diastolic blood pressure between 100 to 120 mmHg. In the normotensive group, more than half (51.7%) of the respondents had systolic blood pressure between 110 to 119 mmHg and less than two-thirds (63.3%) had diastolic blood pressure between 70 to 79 mmHg. In both hypertensive and normotensive group, the majority of the respondent's MCV level was 76-94 fL, MCH 27-32 Pg and MCHC 31-35 gm/dl. The hematological parameters including mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH) and mean corpuscular hemoglobin concentration (MCHC) were significantly increased in the hypertensive group compared to the normotensive group (p<0.001, p<0.001 and p=0.001 respectively).* ***Conclusion:*** *By regular investigation of Red Cell Indices, it is possible to diagnose early hypertension, and appropriate measures might be taken to prevent hypertension related complications. Information from the study might be helpful for the concerned people to take appropriate measures for hypertensive patients and the basis for further in-depth study on this issue.*

Key words: Hypertension, MCV, MCH, MCHC.
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Introduction

Hypertension is a major health problem and still the leading cause of morbidity worldwide[1]. The global burden of hypertension was estimated to be 1.4 billion in 2010 and is likely to surpass 1.6 billion by 2025[2]. However, the blood pressure control rate was only about 32.5% worldwide among patients being treated[3]. It is one of the strongest risk factors of cardiovascular disease[4] and leads to functional disturbances of hematological parameters. Hypertension is a condition in which systemic arterial pressure is elevated above the normal value. It is indicated by the highest systolic and diastolic arterial pressures. Systolic pressure occurs during contraction of the left ventricle of the heart while diastolic pressure occurs in diastolic or relaxation phase. Normally at rest the systolic pressure is within 100-140 mmHg and diastolic pressure is within 60-90 mmHg[5].

Many factors contribute to the regulation of blood pressure. Renal dysfunction, peripheral resistance, vessel tone, endothelial dysfunction, autonomic tone and neurohumoral factors are responsible for the development of hypertension[6]. Furthermore, environmental factors such as overweight/ obesity, unhealthy diet, excessive dietary sodium,

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insufficient potassium in the diet, insufficient physical activity and alcohol consumption are linked to poor control of blood pressure[7]. There are two types of hypertensions - primary and secondary hypertension. In primary hypertension, 95% of cases have no specific underlying causes and it is called essential hypertension. Among essential hypertension, approximately 40-60% is explained by genetic factors. Age is an important risk factor behind it and other factors include high salt intake, heavy consumption of alcohol, obesity and lack of exercise. Secondary hypertension occurs in 5% cases due to diseases such as kidney disease, endocrine disorder and narrowing of aorta or kidney arteries[8].

Hypertension may lead to severe end-organ damage, coronary heart diseases and stroke which constitute the leading cause of mortality[9]. It is strongly associated with functional and structural abnormalities in organs that are involved in hematopoiesis. Blood viscosity is increased in most patients with high blood pressure. Although, the details of this association are unclear, development of hypertension is accompanied by reduction in deformability and an increase in size, number and agreeability of red blood cells[10]. These red blood cell abnormalities can interfere with microcirculation and enhance end-organ damage. On the other hand, hypertension has an impact on red cell indices such as MCV, MCH & MCHC. Impaired hematological parameters may strongly indicate hypertensive end-organ damage, specifically kidney failure. Low hemoglobin levels are associated with greater heart failure severity, higher left ventricular mass index and higher hospitalization and mortality rates[11].

The pathophysiology of hypertension is multifactorial which is affected by sympathetic over activity contributing to alterations in hematological parameters like viscosity and hypercoagulability of blood. These factors change the kinetics of blood flow acting as contributory risk factors for coronary artery diseases, stroke and thromboembolism. Thus, the red cell indices parameters give an idea about the prognosis of the diseases. Evaluation and monitoring of these factors help to reduce the hypertension associated morbidity and mortality[12]. Elevation of red cell indices has co-relation with moderate to severe hypertension. The elevation of hematocrit in hypertension is due to transcapillary volume shift from the intravascular to the interstitial compartment. Increased hematocrit with the reduction of plasma volume is responsible for borderline hypertension in both gender[13]. So, this study was undertaken to analyze and compare the relationship between blood pressure (Systolic and Diastolic) and red cell indices of hypertensive patients and normotensive individuals in Rajshahi city. The association of altered red cell indices and hypertension helps us for early diagnosis and to take appropriate measures by which we can prevent the complications of hypertension.

Materials and Methods

This cross-sectional comparative study was carried out in the Department of Physiology in collaboration with OPD Department of Medicine in Rajshahi Medical College from January 2019 to December 2019 among the hypertensive patients and normotensive adults in Rajshahi. Ethical clearance for this study was taken from the IERB of Rajshahi Medical College, Rajshahi (ref: RMC/ERC/2020/200/224). The study population was hypertensive patients and normotensive adults with the age of 30-60 years residing in Rajshahi city who fulfilled all the inclusion and exclusion criteria.

A purposive sampling technique was used, and the final sample size was 120. Consulting with the guide and reviewing the previously published literature, the questionnaire was developed for the study. Prior to data collection, respondents were briefed about the purpose of the study and their informed written consent was taken. After taking informed written consent, complete history taking, and physical examinations were done and recorded in preformed data sheet. In this study hypertensive respondents were considered who were diagnosed as hypertensive in the last 6 months and did not take any anti-hypertensive medications. In both groups, blood pressure is measured by a Sphygmomanometer with appropriate cuffs. Systolic BP is the point at which the first of two or more sounds is heard (Phase I) and diastolic BP is the point before the disappearance of sounds (Phase V).

In this study hypertensive respondents were selected purposively when systolic blood pressure ≥140 mmHg and diastolic blood pressure ≥90 mmHg. And normotensive respondents were selected when systolic blood pressure <120 mmHg and diastolic blood pressure <80 mmHg. Respondents who had prehypertension such as systolic blood pressure 120-139 mmHg or diastolic blood pressure 80-89 mmHg were excluded from the study. In the study, initially total 300 respondents were recruited (among them 150 were hypertensive and 150 were normotensive). Among them blood pressure was measured with standard procedure. Following a standardized protocol, three separate measurements with intervals of 5 minutes were recorded after 30 minutes' rest in a comfortable chair and finally the average of the three measurements was recorded[6]. Finally, 60 hypertensive respondents were recruited whose systolic blood pressure ≥140 mmHg and diastolic blood pressure ≥90 mmHg. Besides 60 normotensive respondents were recruited whose systolic blood pressure <120 mmHg and diastolic

blood pressure <80 mmHg. Blood samples were obtained from the median cubital vein in antecubital fossa making the subject sit comfortably in a chair. Under all aseptic precautions, about 3 ml of blood is collected in EDTA coated vacutainers. The sample was then analyzed for the hematological parameters using an auto analyzing machine. The readings for the values of Hemoglobin, RBC Count and Hematocrit were taken and from these parameters MCV, MCH & MCHC were calculated. The statistical significance was evaluated as appropriate probability level p <0.05 for all tests.

Results

The study population was hypertensive patients (n=60) and normotensive adults (n=60) with the age of 30-60 years residing in Rajshahi city. Among the hypertensive patients 30 subjects were male and 30 subjects were female. In non-hypertensive group there were also 30 male subjects and 30 female subjects (figure-1). In hypertensive group, more than half (53.3%) of the respondents had systolic blood pressure between 140-159 mmHg, more than 2/5th (43.3%) had between 160-180 mmHg and only 3.3% had >180 mmHg. In the normotensive group, more than half (51.7%) of the respondents had systolic blood pressure between 110-119 mmHg and less than half (48.3%) of the respondents had between 100-109 mmHg (table-I).

In hypertensive group, less than three-quarter (73.3%) of the respondents had diastolic blood pressure between 100-120 mmHg, 1/6th (16.7%) had between 90-99 mmHg and only 1/10th (10%) had >120 mmHg. In the normotensive group, less than two-thirds (63.3%) of the respondents had diastolic blood pressure between 70-79 mmHg and more than one-third (36.7%) had between 60-69 mmHg (table-II). MCV level among the hypertensive group revealed that 51.7% hypertensive respondents had MCV value 76-94 fL, 45% had >94 fL and only 3.3% had <76 fL. On the other hand, majority (96.7%) of the normotensive respondents had MCV level 76-94 fL and only 3.3% had >94 fL. The MCV value in the hypertensive group (89.69±12.40) was significantly higher than the normotensive group (82.36±4.97) and it was statistically significant (p<0.001) (table-III).

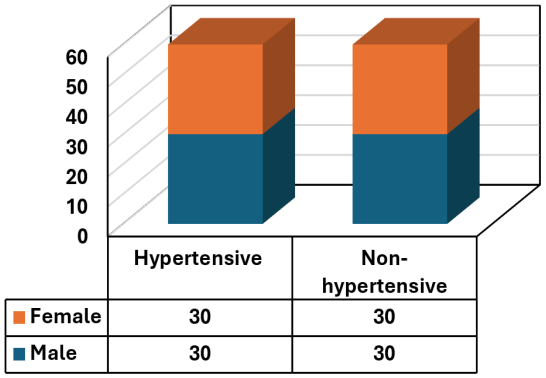

Figure-1: Gender distribution of the study subjects (n=120)

Table-I: Distribution of the respondents according to their systolic blood pressure (n=60 in each group)

SBP of the respondents	Hypertensive (n=60)	Normotensive (n=60)
100-109 mmHg	0 (0%)	29 (48.3%)
110-119 mmHg	0 (0%)	31 (51.7%)
140-159 mmHg	32 (53.3%)	0 (0%)
160-180 mmHg	26 (43.3%)	0 (0%)
>180 mmHg	2 (3.3%)	0 (0%)
Total	**60 (100%)**	**60 (100%)**

Table-II: Distribution of the respondents according to their diastolic blood pressure (n=60 in each group)

DBP of the respondents	Hypertensive (n=60)	Normotensive (n=60)
60-69 mmHg	0 (0%)	22 (36.7%)
70-79 mmHg	0 (0%)	38 (63.3%)
90-99 mmHg	10 (16.7%)	0 (0%)
100-120 mmHg	44 (73.3%)	0 (0%)
>120 mmHg	6 (10%)	0 (0%)
Total	**60 (100%)**	**60 (100%)**

Table-III: Comparison of MCV value between hypertensive and normotensive group (n=60 in each group)

MCV level (fL) with cut point value	Hypertensive (n=60)	Normotensive (n=60)	t-value	p-value
<76 fL	2 (3.3%)	0 (0.0%)	4.25	<0.001
76-94 fL	31 (51.7%)	58 (96.7%)		
>94 fL	27 (45.0%)	2 (3.3%)		
Mean ± SD	**89.69 ± 12.4**	**82.36 ± 4.97**		

Table-IV: Comparison of MCH value between hypertensive and normotensive group (n=60 in each group)

MCH level (Pg) with cut point value	Hypertensive (n=60)	Normotensive (n=60)	t-value	p-value
<27 Pg	0 (0%)	4 (6.7%)	6.21	<0.001
27-32 Pg	57 (95%)	56 (93.3%)		
>32 Pg	3 (5%)	0 (0%)		
Mean ± SD	**29.93 ± 0.90**	**28.44 ± 1.62**		

Table-V: Comparison of MCHC value between hypertensive and normotensive group (n=60 in each group)

MCHC level (gm/dl) with cut point value	Hypertensive (n=60)	Normotensive (n=60)	t-value	p-value
<31 gm/dl	2 (3.3%)	5 (8.3%)	3.48	0.001
31-35 gm/dl	48 (80%)	47 (78.3%)		
>35 gm/dl	10 (16.7%)	8 (13.3%)		
Mean ± SD	**34.14 ± 1.52**	**33.11 ± 1.70**		

Discussion

Hypertension is the most widely prevalent, largely preventable risk factor for cardiovascular diseases (CVD)[14]. It causes great changes in hematological parameters. This cross-sectional comparative study was conducted to evaluate the red cell indices (MCV, MCH & MCHC) of hypertensive and normotensive individuals in Rajshahi city. A total of 120 study subjects (60 hypertensive and 60 normotensive) were involved in the study to compare red cell indices (MCV, MCH & MCHC) among hypertensive and normotensive individuals. The cause behind the relationship is the hematological parameters that increase blood viscosity and directly affect the total peripheral resistance which is the major determining factor to increase blood pressure[15].

The mean level of MCV in hypertensive group was 89.69±12.4 fL and in control group it was 82.36±4.97 fL. MCV value in hypertensive group was significantly higher than the normotensive group (p<0.001). These findings were in accordance with studies done by Dan, et al.[16], Giacomo, et al.[17], Cabrales, et al.[18], Haltmayer, et al.[19] and Enawgaw, et al[20]. But those values were not consistent with the studies done by Babu, et al.[21] and Al-Muhana, et al[12]. But dissimilar findings were found in a study done by Babu, et al[21] where there were decreased MCV in primary hypertensives and the mean levels of MCV in hypertensives was 81.95±9.73 fL and in controls it was 87.56±7.47 fL[21]. This dissimilarity might be due to our study excludes the pregnant women, but their study includes the pregnant women which causes hemodilution that decreased viscosity and affects peripheral resistance of blood flow, and the peripheral resistance affects DBP.

In the present study, the mean levels of MCH in hypertensive group was 29.93±0.90 Pg and in control group it was 28.44±1.62 Pg. MCH value in hypertensive group was significantly higher than the normotensive group (p<0.001). These findings were in accordance with study done by Babu, et al[21]. Our results conflicted with Al-Muhana, et al[12]. They found that mean level of MCH in BP controlled male respondents was 27.16±3.30 Pg and in BP poorly controlled male respondents was 28.43±2.70 pg. On the other hand, mean level of MCH in BP controlled female respondents was 26.63±3.82 Pg and in BP poorly controlled female respondents was 26.58±3.16 Pg. This inconsistency might be because we did the significant test in both male and female all together but Al-Muhana, et al.[12] had done significant test male and female separately.

In the current study, the mean levels of MCHC in hypertensive group was 34.14±1.52 mg/dl and in control group it was 33.11±1.70 mg/dl. MCHC value in hypertensive group was significantly higher than the normotensive group (p=0.001). These findings were in accordance with studies done by Enawgaw, et al.[20] and Babu, et al[21]. A study conducted by Al-Muhana, et al.[12] found that mean level of MCHC in BP controlled male respondents was 34.18±1.23 mg/dl and in BP poorly controlled male respondents it was 34.10±1.04 mg/dl. On the other hand, mean level of MCHC in BP controlled female respondents was 33.99±1.31 mg/dl and in BP poorly controlled female respondents it was 33.45±0.99 mg/dl. There was no statistically significant elevation of MCHC levels in BP poorly controlled male hypertensive patients in comparison to BP controlled group (p>0.05) and same findings in case of female which is not consistent with our study findings[12]. This inconsistency might be due to it was done significant test both male and female all together but Al-Muhana, et al.[12] had done the significant test of male and female separately. According to the present study findings, it could be

notified that red cell indices parameters were related to hypertension, which might be the risk factors for CVD and its associated diseases. So, for early detection and prevention of hypertension, the routine blood test might be an effective tool.

Conclusion

In this study there were statistically significant positive correlations of MCV, MCH and MCHC with high blood pressure. It was concluded that routine monitoring of CBC parameters among hypertensive individuals should be carried out and used to monitor the prognosis of the disease and to prevent hypertensive related complications.

Limitation of the study

The study was conducted only on the attendants of Rajshahi Medical College & Hospital. So, the study result might not reflect the exact scenarios of the whole country and effects of high blood pressure with other systemic diseases were not observed separately.

Conflict of interest

The authors declared that they have no conflict of interest.

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