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Left Ventricular Geometry and Function in Patients with Gray Zone Hypertension

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Background: Hypertension is considered as the silent killer of human because the hypertensive patient may be not aware that he has hypertension and death can occur at any time without the reason being known. We aim to study the effect of gray zone hypertension [SBP from 120-139] and or [DBP from 80-89] which was classified as prehypertension under JNC-7 on the structure, geometry, and operation of the left ventricle using echocardiography
Methods: This study included 100 patients who asymptomatic apparent healthy subjects visited cardiology outpatient department (OPD) for routine checkup. Patients were grouped into two equal groups: Group A whose blood pressure was in the gray zone hypertension [SBP from 120-139] and or [DBP from 80-89], and group B with SBP <120 mmHg & DBP <80 mmHg.
Results: The two groups being studied were statistically significant different as regard LV geometrical pattern (p=0.028). They were also statistically significant in LV geometrical pattern between the males and females (p<0.05). The two groups were statistically significant different regarding GLS (p =0.001).

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Conclusions: Gray zone hypertension affects ventricular diastolic function and LV geometry, although systolic function was normal; GLS showed that subclinical LV dysfunction can occur.

Keywords: Left ventricular geometry; gray zone hypertension; SBP; DBP.

1. INTRODUCTION

Hypertension is considered as the silent killer of human because the hypertensive patient may be not aware that he has hypertension and death can occur at any time without the reason being known [1].

Prehypertension category is now eliminated by the updated guidelines as it was used before for patients with 120-139 mmHg as systole and 80-89 mmHg as diastole. They are categorized now as having elevated hypertension if the reading is 120-129 and less than 80 or categorized as having stage I hypertension if the reading is 130-139 or 80-89 [2].

According to older definitions, stage 1 hypertension was defined as 140/90 mm Hg. The most recent recommendations classify this level of hypertension as Stage 2 hypertension [2].

Prehypertension impacts the community greatly, despite the fact that there are little studies on its prevalence and risk factors [3].

Persistent increase in blood pressure results in many complications including the occurrence of coronary artery disease (CAD), angina pectoris, myocardial infarction, hypertrophy of left ventricle, congestive heart failure and heart arrhythmias. They occur as a result of damaging effects in the structure of the heart, coronary blood vessels and the mechanisms of heart conduction [1].

LVM (left ventricular mass) increases can either be detrimental or healthy. Age, nutrition, daily nutrition of salt, sex, inheritance, psychological pressure, blood pressure, body size, physical activity, viscosity of the blood, increasing in age, and weight gain are a few factors associated with an expanded LVM [4].

It has been determined that hypertension, diabetes, and obesity are the three main risk factors for an enlarged LVM [4].

The early detection of aging-related changes in LV wall thickness, LV mass, and LV hypertrophy is made possible by echocardiography. Due to adaptive responses, pre-hypertensives do not yet exhibit symptoms in daily life, but it is nevertheless important to recognise them and watch for any potential long-term structural changes to the cardiovascular system [5].

We aim to study the effect of grey zone hypertension [SBP from 120-139] and or [DBP from 80-89] which was classified as prehypertension under JNC-7 on the structure, geometry, and operation of the left ventricle using echocardiography.

2. METERIALS AND METHODS

This study included 100 patients who asymptomatic apparent healthy subjects visited cardiology outpatient department (OPD) for routine checkup at Tanta university hospital and Zifta general hospital from the period of January 2021 to July 2021.

Among the exclusion criteria were hypertrophic cardiomyopathy as determined by echocardiographic findings, congestive heart failure, diabetes mellitus, congenital heart disease, rheumatic heart disease, unstable or stable angina, valvular heart disease, pericardial disease, respiratory disease, kidney disease, and thyroid dysfunction [6].

Patients were divided in to two equal groups: Group A whose blood pressure was in the gray zone hypertension [SBP from 120-139] and or [DBP from 80-89], and group B with SBP <120 mmHg & DBP <80 mmHg.

All participating patients underwent: Careful history taking, general and local examination (Blood pressure measurement), resting surface 12 lead ECG, transthoracic echocardiography, and speckle tracking echocardiography.

Transthoracic Echocardiography: We reported the following measurements: interventricular septal wall thickness at end diastole (IVSd), left ventricle posterior wall thickness at end diastole (LVPWd), left ventricle internal dimension measured at end systole (LVIDs), left ventricle internal dimension measured at end diastole (LVIDd), and then by using these measurements we derived LV mass using cube equation by linear method and early diastolic mitral inflow velocity/late early diastolic mitral inflow velocity

(E/A), early diastolic mitral inflow velocity/peak early diastolic mitral septal annular velocity (E/e'), measured by flow and tissue Doppler analysis; and left ventricular mass index (LVMI), left ventricular mass divided by (BSA), measured with M-mode. All measurements were performed based on the American Society of Echocardiography's chamber quantification guidelines [7].

Relative wall thickness (RWT) = 2 × PWT /LVIDd. LVMI and RWT were used to determine the pattern of LV remodelling. Useful for classifying the remodelling pattern and LV mass.

Patient was reported to have normal geometry (NG) if both values of LVMI and RWT are within known normal range (males -118/0.50; females-107/0.47), While eccentric hypertrophy (EH) results include increased LVMI and decreased RWT (males >118/ 0.50; females >107/ 0.47), concentric remodelling (CR) results are normal value of LVMI and increased value of RWT (males -118/ >0.50; females- 107/ >0.47), whereas concentric hypertrophy (CH) results include increased LVMI and RWT (males > 118/ >0.50; females >107/ >0.47) [7].

Calculation of body surface area and body mass index: (BSA) = [(Ht (cm) × Wt. (Kg) /3600] ½. BMI = Wt. (kg) /Ht (m) ^{2}.

2.1 Statistical Analysis

The Statistical Package for Social Science (SPSS) version 20.0 was utilised to analyse the data. Quantitative variables were presented using the means and standard deviation (SD). Comparison between two means of different groups was carried out using independent student t test. The qualitative variables were provided as frequency and percentage (%). Comparison among these variables was done using Chi-square test. Two-tailed P values of 0.05 were used to determine significant results.

3. RESULTS

Gender, age and height were not statistically significant different between the two participating groups. Group B had a significantly higher BMI and body weight as compared to group A (P value =0.004, 0.02 respectively). Group B had a significantly lower SBP, DBP and heart rate if we compare it to group A (P<0.001).

The two groups being studied were statistically significant different regarding E/A, LVIDs, E/e`, LV mass, LVMI, (p value 0.001).

The two groups being studied were statistically significant different as regard LV geometrical pattern (p=0.028).

They two groups were statistically significant in LV geometrical pattern between the males and females (p<0.05). They were also statistically significant different regarding GLS (p =0.001).

4. DISCUSSION

One of the morpho-functional alterations, known as LV hypertrophy (LVH), is the primary biomarker of subclinical cardiac injury and the cause of so-called hypertensive heart disease. For a more precise outcome, electrocardiography is routinely utilised to detect LVH [8].

Table 1. Age, sex, height, weight, BMI, SBP, DBP and Heart rate distribution among group A and group B

		Group B (N=50)	Group A (N=50)	p value
Age (years)		47.38 ± 7.5	46.9 ± 9.1	0.7
Sex	**Males**	38 (76%)	33 (66%)	0.2
	Females	12 (24%)	17 (34%)	
Height (m)		1.73 ± 0.085	1.72 ± 0.085	0.7
Weight (Kg)		78.76 ± 9.2	83.14 ± 10.06	0.02*
BMI		26.4 ± 1.7	27.7 ± 2.6	0.004*
SBP		109.3 ± 4.8	129.06 ± 4.6	<0.001*
DBP		72.7 ± 4.4	84.6 ± 2.2	<0.001*
HR		75.02 ± 6.6	84.6 ± 2.2	0.001*

*Data are reported in the form of mean ± SD or frequency (%). BMI: Body mass index, SBP: Systolic blood pressure, DBP: Diastolic blood pressure, *: significant P value*

Table 2. Echocardiography parameters distribution among cases and control groups

Parameter	Group B (N=50)	Group A (N=50)	p value
BSA	1.99 ± 0.15	1.94 ± 0.15	0.07
Ao D	29.7 ± 1.7	29.5 ± 2.3	<0.001*
LAD	32.7 ± 2.06	32.02 ± 2.3	0.1
EF (%)	63.4 ± 4.6	63.1 ± 4.5	0.7
FS%	35.6 ± 3.05	34.6 ± 3.7	0.1
LVIDd	44 ± 1.4	44.02 ± 1.4	0.9
LVIDs	23.9 ± 0.9	24.9 ± 0.9	<0.001*
IVST	8.5 ± 1.07	8.6 ± 1.1	0.5
LVPWd	8.8 ± 1.08	8.9 ± 1.1	0.5
SV	71.5 ± 8.1	69.9 ± 7.9	0.3
COP	5.3 ± 0.69	6.6 ± 7.5	0.2
RWT	0.39 ± 0.05	0.4 ± 0.05	0.6
E/A	1.24 ± 0.04	1±0.14	0.001*
E/e'	7.04 ± 1.4	8 ± 1.4	0.001*
LV mass	132.8 ± 13.4	174.6 ± 12.7	<0.001*
LVMI	66.7 ± 8.7	98.6 ± 8.4	<0.001*

*Data is reported in the form mean ± SD, *: significant P value, BSA: body surface area, E/e': velocity, EF: ejection fraction, FS: Fractional shortening, LVIDd: left ventricle internal dimension measured at end diastole, LVPWd: left ventricle posterior wall thickness at end diastole, SV: stroke volume, RWT: relative wall thickness, LV: left ventricular, LVMI: Left ventricular mass index*

Table 3. Comparison of the LV geometrical pattern in the two study groups

Variable	Group A (Gray zone hypertension) (N= 50)	Group B (Control group) (N= 50)	P value
Normal geometry	40 (80%)	50 (100%)	0.028*
Concentric remodeling	2 (4%)	0(0%)	
Eccentric hypertrophy	2 (4%)	0 (0%)	
Concentric hypertrophy	6 (12%)	0 (0%)	

*Data are presented as frequency (%), *: significant P value*

Table 3. Comparison of the LV geometrical pattern in the males and females in the two study groups

Males	Gray zone hypertension (N= 33)	Control group (N= 38)	P value
Normal geometry	27 (81.8%)	38 (100%)	0.019*
Concentric remodeling	1 (3%)	0 (0%)	
Eccentric hypertrophy	1 (3%)	0 (0%)	
Concentric hypertrophy	4 (15.2%)	0 (0%)	
In females			
Normal geometry	13 (76.5%)	12 (100%)	0.032*
Concentric remodeling	1 (5.9%)	0 (0%)	
Eccentric hypertrophy	1 (5.9%)	0 (0%)	
Concentric hypertrophy	2 (11.8%)	0 (0%)	
Global longitudinal strain	-19.1 ± 1.1	-15.9 ± 1.3	<0.001*

*Data are presented as mean ± SD or frequency (%), *: significant P value*

In the current study, among group A there were 17/50 female patients (34 %) and 33 male patients (66 %). While in group B there were 12 /50 female (24%) and 38 male (76%). No statistically significant difference existed between the two study groups.

This was similar to findings by Cuspidi et al. [9] who showed that males represented 57.3% of the patients with prehypertension included in their study. However, they reported a statistically significant difference if being compared to the control group. The absence of significance may arise from the small sample size participating in the current study.

Women had greater aortic stiffening, as indicated by higher aortic characteristic impedance (Zc), which should translate into a greater rise in blood pressure from increased flow during LV ejection, according to another study that examined sex differences in arterial stiffness and ventricular-arterial interactions in an older population (men and women) [10].

In the current study, the mean BMI group B was 26.40 ± 1.72 kg/m2 while in group A, the mean BMI was 27.73 ± 2.63 kg/m2. There was a statistically significant difference between the two studied groups. (P value = 0.003). This agreed with Cuspidi et al. [9] who showed that there was a statistically significant difference in the mean BMI between the cases with prehypertension and normal people included in their study.

On the other hand, Mousa et al. [10] reported that there was no statistically significant difference in the BMI among the two groups being studied (prehypertensive and normotensive) included in their study.

In the current study, the mean SBP, DBP and MAP were statistically significantly higher in the patients with prehypertension if compared with the control group. This was in accordance with Cuspidi et al. [9] who showed that patients suffering from prehypertension have greatly higher out-of-office measurements of BP whether at systole or diastole, as well as an about 6-fold of increased occurrence of silent hypertension than normotensive patients.

In the current study, the mean HR in the pre hypertensive group was 84.6 ± 2.2 b/min that was statistically significantly higher as compared with normotensive group (75.02 ± 6.61 b/min) (p< 0.001).

Adrenergic tone is raised in the early phases of prehypertension, which is generally accompanied by hyperkinetic state i.e. an increased heart rate, cardiac output, stroke volume, and CI, including TPR [11].

In the current study, as regard E/A the mean in group A was (0.9 ± 0.14) while in group B the mean was (1.24 ± 0.04). The two groups being studied were statistically significant different regarding E/A: p value 0.001. This came in accordance with Bajpai et al. [1] who showed that E/A ratio was statistically significantly of less value in the prehypertension patients as compared to the healthy people.

In the current study, the mean LVM in the prehypertension patients was 174.6 ± 12.7 which was statistically significantly higher than the cases with normal BP (132.8 ± 13.4) (p< 0.001). also, the mean LVMI in the prehypertension patients was 98.6 ± 8.4 which was statistically significantly higher than the cases with normal BP (66.7 ± 8.7) (p< 0.001). Within the same context, Mousa et al. [10] showed that the mean LVMI in the prehypertensive patients was 34.45±7.4 that was statistically significantly higher as compared to the normotensive group (29 ± 6) (p=0.002).

Opposite to this, Zhu et al. [12] did not discover any statistical differences between normotensives and prehypertensive patients in LVMI. The divergent outcomes across these studies may have been caused by methodological discrepancies (such as age groups of participants in the study, inclusion criteria, and protocol of measurement of ambulatory BP).

In the current study, as regard LVIDs the mean in group A was (24.9 ± 0.9), while in group B the mean was (23.9 ± 0.9). There was statistically significant difference between two studied groups regarding LVIDs: p value 0.001. This was consistent with Li et al. [13] who demonstrated that the LVIDd, LVIDs, LVMI, LVEDV, LVESV, and SV values, which represent ventricular volume indexes, were higher in the people having prehypertension than in the normal healthy group, which says there may have been cardiomegaly, LV remodeling, and increased volume of left ventricle in people with prehypertension status.

In the current study, regarding the LV geometrical pattern, in cases within group A, normal geometry was detected in 40 cases (80%), Concentric remodeling was detected in 2 cases (4%), Eccentric hypertrophy was detected

in 2 cases (4%) and Concentric hypertrophy in 6 cases (12%) while in group B, normal geometry was detected in 50 cases (100%). A statistically significant difference was found between the two groups (p=0.028). According to the same context, concentric remodeling and concentric hypertrophy were common in the populations with hypertension that were the subject of various research [14,15].

Eccentric hypertrophy was, however, the most common type of LVH in normotensive (5.9%) and prehypertensive (14.2%) people, according to Cuspidi et al's study [9]. The eccentric/concentric LVH ratio is gradually lower than prehypertensive (1.2) and normotensive (1.7).

When LVIDd, IVST, LVPWd, and RWT were compared between the two groups in the current study, there was no statistically significant difference between the two groups. This was consistent with the results of Bajpai et al. , who showed that PWT, IVST, and RWT were higher in prehypertensive males and females but not significantly, probably as a result of early hyperdynamic circulation and LV wall stress. RWT provides LV geometry information that is unrelated to additional calculations.

In our study, GLs was performed in 10 patients and 10 normal subjects; the mean GLs in group A was (-15.9 ± 1.3) While in group B the mean was (-19.1± 1.1). There was statistically significant difference between two studied groups regarding GLS: (p value 0.001). This came in accordance with Fu et al. [16] who showed that GLS was lower (‘worse’) in the prehypertensive group being compared with the normotensive group (202).

In the current study, regarding the LV geometrical pattern, in cases within female patients in group A, normal geometry was detected in 13 cases (76.5%), Concentric remodeling was detected in 1 case (5.9%), Eccentric hypertrophy was detected in 1 case (5.9%) and Concentric hypertrophy in 2 cases (11.8%) while in female patients in group B, normal geometry was detected in 12 cases (100%). A statistically significant difference between the two groups was reported (p=0.032). Li and his colleagues [13] reported that patients with geometrical changes in LV were most probably females.

Limitations: 1. Awareness of population to do further evaluation. Small number of patients.so large number is needed. Fewer patients only were subjected to speckle tracking echocardiography due to in availability of the technology in echo machines.

5. CONCLUSIONS

Gray zone hypertension affects ventricular diastolic function and LV geometry, although systolic function was normal; GLS showed that subclinical LV dysfunction can occur.

ETHICAL APPROVAL AND CONSENT

We conducted the study after getting the approval from the Ethical Committee Tanta University. We obtained an informed consent from each participant.

DISCLAIMER

This paper is an extended version of a Thesis document of the same author.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Bajpai JK, A PS, A KA, A KD, Garg B, Goel A. Impact of prehypertension on left ventricular structure, function and geometry. J Clin Diagn Res. 2014;8:Bc07-10.
2. Association AH. High blood pressure redefined for first time in 14 years: 130 is the new high. 2017.
3. Al-Ghamdi S, Shubair MM, Aldiab A, Al-Zahrani JM, Aldossari KK, Househ M, et al. Prevalence of overweight and obesity based on the body mass index; a cross-sectional study in Alkharj, Saudi Arabia. Lipids Health Dis. 2018;17:134.
4. D'Ascenzi F, Anselmi F, Piu P, Fiorentini C, Carbone SF, Volterrani L, et al. Cardiac Magnetic Resonance Normal Reference Values of Biventricular Size and Function in Male Athlete's Heart. JACC Cardiovasc Imaging. 2019;12:1755-65.

5. Díaz A, Zócalo Y, Bia D, Sabino F, Rodríguez V, Cabrera FEI. Reference intervals of aortic pulse wave velocity assessed with an oscillometric device in healthy children and adolescents from Argentina. Clin Exp Hypertens. 2019;41: 101-12.
6. Strähl M, Schindler M, Keller LS, Holy E, Jakob P, Siegrist PT, et al. Diagnostic performance of angiography-based quantitative flow ratio for the identification of myocardial ischemia as assessed by (13)N-ammonia myocardial perfusion imaging positron emission tomography. Int J Cardiol. 2020;314:13-9.
7. Lang RM, Badano LP, Mor-Avi V, Afilalo J, Armstrong A, Ernande L, et al. Recommendations for cardiac chamber quantification by echocardiography in adults: an update from the American Society of Echocardiography and the European Association of Cardiovascular Imaging. J Am Soc Echocardiogr. 2015;28: 1-39.e14.
8. Treibel TA, Kozor R, Menacho K, Castelletti S, Bulluck H, Rosmini S, et al. Left Ventricular Hypertrophy Revisited: Cell and Matrix Expansion Have Disease-Specific Relationships. Circulation. 2017; 136:2519-21.
9. Cuspidi C, Facchetti R, Bombelli M, Tadic M, Sala C, Grassi G, et al. High Normal Blood Pressure and Left Ventricular Hypertrophy Echocardiographic Findings From the PAMELA Population. Hypertension. 2019;73:612-9.
10. Mousa TM, Akinseye OA, Berekashvili K, Akinboboye OO. Correlation of Prehypertension with Left Ventricular Mass Assessed by Cardiac Magnetic Resonance Imaging. Int J Hypertens. 2015;2015: 742658.
11. Shimbo D, Newman JD, Schwartz JE. Masked hypertension and prehypertension: diagnostic overlap and interrelationships with left ventricular mass: the Masked Hypertension Study. American journal of hypertension. 2012;25:664-71.
12. Zhu H, Yan W, Ge D, Treiber FA, Harshfield GA, Kapuku G, et al. Relationships of cardiovascular phenotypes with healthy weight, at risk of overweight, and overweight in US youths. Pediatrics. 2008;121:115-22.
13. Li T, Yang J, Guo X, Chen S, Sun Y. Geometrical and functional changes of left heart in adults with prehypertension and hypertension: a cross-sectional study from China. BMC Cardiovasc Disord. 2016;16:114.
14. Akintunde AA, Akinwusi PO, Opadijo GO. Relationship between Tei index of myocardial performance and left ventricular geometry in Nigerians with systemic hypertension. Cardiovasc J Afr. 2011;22:124-7.
15. Wang SX, Xue H, Zou YB, Sun K, Fu CY, Wang H, et al. Prevalence and risk factors for left ventricular hypertrophy and left ventricular geometric abnormality in the patients with hypertension among Han Chinese. Chin Med J (Engl). 2012;125: 21-6.
16. Fu M, Hu X, Sun S, Yi S, Zhang Y, Feng Y, et al. Relationship Between Masked Hypertension Measured by Ambulatory Blood Pressure Monitoring and Left Ventricular Global Longitudinal Strain: A Retrospective Study. Int J Gen Med. 2021;14:2053-61.

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