Original Article

EFFECTS OF HYPERTENSION ON LEFT VENTRICULAR WALL SIZE IN NIGERIANS FROM THE OWERRI HEART STUDY

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Abstract

Background and Purpose – The rising prevalence of hypertension in Nigerians may account for the increase in rate of cardiac diseases, most often associated with left ventricular hypertrophy (LVH), an end-point measure of cardiac end-organ damage. The study cohort drawn from the Owerri Heart Study (OHS) were examined to determine the left ventricular posterior wall thickness (LVPWT) at the different levels of blood pressure according to the classification of the Seventh Joint National Committee (JNC 7) report.

Methods – One hundred and eighty consecutive patients including 108 men and 72 women of mean age 53.2±14 years, were clinically evaluated by measurements of systolic (SBP) and diastolic (DBP) blood pressure using mercury sphygmomanometer. The blood pressures were classified according to the JNC 7 report. The LVH was determined by measurement of left ventricular posterior wall thickness (LVPWT) using two dimensional (2-D) Color Flow Echocardiography.

Results - Patients with normal blood pressure (SBP = 114.7±11.7 mmHg, DBP = 69.4±3 mmHg) were n=17, the LVPWT = 14.1±2.2mm. Patients with Pre-hypertension (SBP = 133.8±18.5 mmHg, DBP = 80.1±0.85 mmHg) were n = 33, LVPWT = 15.4±2.74mm. Patients with Stage 1 hypertension (SBP = 144±13.9 mmHg, DBP = 90.1±0.9 mmHg) were n = 59, LVPWT = 15.2±2.6mm. Patients with Stage 2 hypertension (SBP = 159.6±20.6 mmHg, DBP = 106.7±10.4 mmHg) were n=71, LVPWT = 16.67±3.5mm. Analysis of variance (ANOVA) revealed significant differences in SBP $F(3, 176) = 37.68$, $p< 0.0001$, DBP $F(3, 176) = 217.7$, $p< 0.0001$, and LVPWT $F(3, 176) = 4.66$, $p< 0.01$.

Conclusion – The LVPWT at prehypertension did not differ significantly ($p> 0.05$) with the LVPWT of normatensives, hypertension Stage 1 and Stage 2. This may suggest that the distinction of prehypertension may include patients with blunted nocturnal fall in BP defined as 'non-dippers' that has been associated with increase in left ventricular mass index. This may suggest that, patients with prehypertension should be evaluated for LVH and if present, there should be no delay in early therapeutic intervention with antihypertensive drugs along lifestyle modification.

Keywords: Hypertension, Cardiac Hypertrophy, Echocardiography, Blood Pressure

Introduction

Left ventricular hypertrophy (LVH) is a marker for end-organ cardiac damage in hypertension [1] and has a well established racial predisposition with blacks having twice higher levels of LVH [2]. The accepted gold standard for determination of LVH is the use of echocardiographically measured left ventricular wall thickness (LVPWT) as an independent risk factor for cardiovascular morbidity, cardiovascular complications and mortality [3]. There is a high prevalence of

hypertension in Nigerians [4] and prevalence of LVH ranged between 38.9-51.3% [5]. The Seventh Report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure (JNC 7) report provides a classification scheme of blood pressure that relies on the level of blood pressure (diastolic, systolic and both) to classify patients based on the level of risk of cardiovascular events occurring as blood pressure rises.

The JNC 7 report proposed that (1) in persons older than 50 years, systolic blood pressure (BP) of more than 140 mmHg is a much more important cardiovascular disease (CVD) risk factor than diastolic BP; (2) that the risk of cardiovascular disease, beginning at 115/75 mmHg, doubles with each increment of 20/10 mmHg; that normatensive persons at 55 years of age have a 90% lifetime risk for developing hypertension; (3) individuals with a systolic BP of 120 to 139 mmHg or a diastolic BP of 80 to 89 mmHg should be considered as prehypertensive and require health-promoting lifestyle modifications to prevent CVD [6]. The critical issue in blood pressure management is to prevent the adverse effects of CVD, hence, the importance of determining at what level of blood pressure antihypertensive medication must be commenced cannot be overemphasized.

The diurnal variation of blood pressure and heart function has been demonstrated [7,8]. Current definitions have identified [9]: (1) Dippers: subjects with a nocturnal fall of systolic or diastolic BP; (2) Non-dippers: subjects with a reduced or absent nocturnal fall of BP; (3) Peakers: subjects with a daytime rise in BP; (4) Non-peakers: subjects without a daytime rise in BP; (5) Night-peakers: subjects with a rise of BP during nighttime; (6) Over-dippers: subjects with a fall in BP during nighttime greater than 20% of daytime BP. The proposed definitions are entirely arbitrary, because the distinction between the physiologic and the pathologic value of the nocturnal reduction in BP is not clear [9]. Moreover, some healthy subjects may also present a reduced or absent circadian rhythm of blood pressure. Furthermore, the JNC-7 classification of BP does not take into account the diurnal variation such that, patients with daytime hypertension, either associated or not with blunted nocturnal fall in BP, may develop LVH [10]. Even when daytime BP was classified as prehypertension stage, individuals who do not have 10% to 20% reduction in BP during the night called 'nondippers' may develop target organ damage including advanced LVH, carotid artery wall thickening, silent cerebral infarcts, stroke, cognitive impairment and microalbuminuria [11]. The objective of the present work is to assess the effects of rising blood pressure on left ventricular wall size in Nigerians from the Owerri Heart Study cohort. It was postulated that patients with prehypertension stage may have significant LVPWT.

Materials and Methods

One hundred and eighty consecutive patients participating in the Owerri Heart Study(OHS) for hypertension detection and follow-up, including 108 men and 72 women of mean age 53.2±14 years, were examined at the echocardiography laboratory at Chidicon Medical Center, Owerri, Imo State, Southeast, Nigeria. The patients were characterized using anthropometric variables for body mass index (BMI). The study was approved by the Institutional Research Committee in conformity with the Declaration of Helsinki with written informed consent of participants. Blood pressure was recorded at rest with mercury sphygmomanometer using Korotkoff phase 1 sound for systolic blood pressure and phase 5 sound for diastolic blood pressure. Blood pressures were obtained on at least three occasions [4] and in addition, some

patients underwent serial 24-hour blood pressure monitoring to observe diurnal variations. The patients were first diagnosed or were not on regular antihypertensive therapy at the time of testing. The exclusion criteria included patients with valvular abnormality, congestive heart failure, ischemic heart disease, renal failure, hemoglobinopathies and diabetes mellitus.

Trans-thoracic 2-D echocardiography with Color Flow Doppler was performed with the ultrasound device (HP SONOS 5500, Philips Medical Systems) using a multi-frequency S4 probe. The patient was placed in a left lateral decubitus position. The end-diastolic LVPWT were taken during three cardiac cycles according to the American Society of Echocardiography convention [12]. The left ventricular volume, area and length were also measured by modified Simpson's rule [13].

Statistical analysis

All analysis were performed using the statistical software package SPSS Statistics 17.0 (WinWrap Basic, Polar Engineering and Consulting, USA). The results were given as meanSD and one-way analysis of variance (ANOVA) with level of significance set at $p < 0.05$, followed by post Hoc Tukey HSD and Bonferroni tests.

Results

Table 1., shows that, there was no age difference between patients with prehypertension and individuals with normal blood pressure ($p > 0.05$); however, individuals with normal blood pressure were younger than those with Stage 2 hypertension ($p < 0.01$); patients with prehypertension were younger than those with Stage 1 ($p < 0.05$) and Stage 2 ($p < 0.0001$) hypertension. Patients with Stage 1 did not differ in age from those with Stage 2 hypertension ($p > 0.05$). The BMI was 27.5, and there was no difference in BMI between any of the groups ($p > 0.05$). Table 2., summarizes the SBP, DBP and LVPWT measurements obtained from all subjects in the different groups of BP. Patients with normal BP (SBP = 114.7±11.7 mmHg, DBP = 69.4±3 mmHg) were n=17, the LVPWT = 14.1±2.2mm. Patients with Pre-hypertension (SBP = 133.8±18.5 mmHg, DBP = 80.1±0.85 mmHg) were n = 33, LVPWT = 15.4±2.74mm. Patients with Stage 1 hypertension (SBP = 144±13.9 mmHg, DBP = 90.1±0.9 mmHg) were n = 59, LVPWT = 15.2±2.6mm. Patient with Stage 2 hypertension (SBP = 159.6±20.6 mmHg, DBP = 106.7±10.4 mmHg) were n=71, LVPWT = 16.67±3.5mm. Analysis of variance (ANOVA) revealed significant differences in SBP $F(3, 176) = 37.68$, $p < 0.0001$, DBP $F(3, 176) = 217.7$, $p < 0.0001$, LVPWT $F(3, 176) = 4.66$, $p < 0.01$, and Age $F(3,176) = 4.4$, $p < 0.01$. The post Hoc tests included Tukey HSD and Bonferroni, both revealed that the normatensive group had lower LVPWT than the group with Stage 2 hypertension ($p < 0.05$). The LVPWT for the prehyertension group did not differ from normatensives, hypertension Stage 1 and Stage 2. However, the LVPWT was lower for hypertension Stage 1 compared to Stage 2, ($p < 0.05$).

Discussion

The main result demonstrates that, LVPWT in prehypertension was not different from that in normatensives, hypertension Stage 1 and Stage 2 groups in the cohort studied. This means that the so-called prehypertension group comprises individuals that may have moderate rise in BP at daytime but very high blood pressures at night called 'night-peakers'. This diurnal variation in blood pressure may account for the increase in LVPWT. This may suggest that, patients with prehypertension should be monitored for 24 hours BP variation, and then appropriately classified. Identifying 'night-peakers' or 'non-dippers' would have significant effect on the decision to commence treatment with antihypertensive drugs in those otherwise classified as

prehypertensives. The diurnal variation of BP would influence the choice of medication and timing regimen of the antihypertensive drug. Physicians would require information about the trough:peak ratio [14] of the antihypertensive drug of choice for such patients. The term trough:peak ratio provides an index of how well the antihypertensive effect is sustained over the dose interval. The ratio is determined from the ratio of the blood pressure reduction at trough, i.e. at the end of the dose interval and before the next dose is administered, relative to the blood pressure reduction at the time of the peak drug effect. The Food and Drug Administration (FDA) of the United States sets 50-60% as the minimum requirement for an acceptable trough:peak ratio [15]. A high trough:peak ratio indicates a long duration of action. Depending on the pattern of the diurnal variation a longer or shorter acting antihypertensive agent could provide an optimal therapeutic coverage for the time duration desired. In patients with night-peaking of BP, greater benefit may be gained from better control of overnight blood pressure, especially in the early morning hours when both steep rise in blood pressure and a higher rate of cardiovascular events have been observed. In the daytime the BP in the prehypertensive patients may not be significantly raised to require a daytime dose of the antihypertensive drug. The choice of the drug must take into account not only the diurnal variations in an individual subject's blood pressure but also of inter individual variability in the timing and the magnitude of the peak response to the antihypertensive medication. The initial diurnal variation of BP without the drug would provide a guide to timing of the dose response with peak response timed to coincide with the time of maximal rise in BP. The antihypertensive medication could be short-acting or long-acting depending on the duration of the night-peaking of BP in the patient. That a patient is classified by daytime BP as in the prehypertension stage should not delay the start of antihypertensive medication but rather should prompt further investigations including using echocardiography to determine LVPWT and 24-hour blood pressure monitoring. Lifestyle modification alone though essential as recommended in the JNC 7 report [6] may not suffice to prevent cardiac end-organ damage. The present data supports early intervention in the prehypertension stage with antihypertensive medication to prevent increase in LVPWT and hence progression to cardiac end-organ damage. The rationale for early intervention with antihypertensive medication is not only to prevent further increase in LVPWT but also other complications of hypertension such as carotid intimal thickening, strokes, cerebral infarcts and heart attacks.

Physicians should turn their focus on early detection of hypertension and early start of antihypertensive medications to prevent end-organ damage. In the present study, the patients with prehypertension were younger than hypertension Stage 1 and State 2, which makes it imperative that the antihypertensive treatment should be commenced as early as possible to prevent co-morbidities. This would involve use of tools for early detection of LVH in hypertension, characterized by measurement of LVPWT using 2-D echocardiography. The cost implications of early detection and start of antihypertensivemedication has a good benefit-cost ratio.There is a likelihood of prevention and even elimination of other cardiovascular complications such as ischemic heart disease and strokes. In Nigeria, the on-going reform in the health sector to create greater access to medical services for the populace should be focused on prevention by early detection and early treatment. Hypertension could be easily detected and the patients placed on both lifestyle modification

and early treatment with medication, which would mean fewer strokes and heart attacks. There is no doubt that lifestyle modification is essential for all normatensives and moreso for hypertensives. Among the most useful lifestyle modifications are exercise, low fat diet and low-salt intake. The impact of these lifestyle modifications have to be assessed in the Nigerian population before their contribution towards overall reduction of blood pressure could be quantified. However, there is need to set targets of blood pressure control much lower than what is presumed in clinical practice today in Nigeria. This would mean the early use of antihypertensive medication that would achieve such targets below 115/75 mmHg according to the JNC 7 [6].

There should be on-going national effort towards early detection and treatment of hypertension. The Owerri Heart Study is one of the new initiatives commenced in 2010, began from Owerri in Imo State, Southeastern Nigeria to identify the peculiarities of risk factors for heart and brain diseases. The study began with a modest 1000 adults subjects and the database. In Nigeria, as the most populous African nation, there is need for a coordinated effort to identify the peculiarities of risk factors for hypertension beyond what has been known from larger international studies such as the Framingham Heart Study (FHS). The FHS was carried out in a different geographic and climatic environment, the racial composition of the subjects, dietary and lifestyle are different from that in Nigeria, so many of the findings may not apply. There is need for synergy among all stakeholders from government, insurance companies, healthcare providers and educators to focus attention on hypertension. The role of a Surgeon General as the spokesperson for disease prevention like hypertension would go a long way to put the problem of systematic detection and treatment as a national priority. An effective strategy towards reduction in the prevalence of heart diseases in Nigeria must take into account early effective blood pressure control.

Table 1. The Age of the groups of blood pressure studied.

	Normal n=17	Prehypertension n=33	Stage 1 n=59	Stage 2 n=71	Total n=180
Age (years)	44.7±17	49.5±15.2	56.7±14.4	58.8±11.8	53.2±14

Table 2. The SBP, DBP and LVPWT measurements in all groups of blood pressure studied.

	Normal n=17	Prehypertension n=33	Stage 1 n=59	Stage 2 n=71	Total n=180
SBP mmHg	114.7±11.7	133.8±18.5	144±13.9	159.6±20.6	145.8±22
DBP mmHg	69.4±3	80.1±0.85	90.1±0.9	106.7±10.4	92.9±14
LVPWT mm	14.1±2.2	15.4±2.74	15.2±2.6	16.67±3.5	15.7±3

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