Original Research Paper

International Physiology 6(2), May - August 2018

DOI: https://dx.doi.org/10.21088/ip.2347.1506.6218.10

Assessment of Left Ventricular Mass Index by Echocardiography in Prehypertensive Subjects

Deepak Kumar Das[1], Sudhir Modala[2], Sharad Kumar Saxena[3], Deep Chandra Pant[4]

Abstract

Introduction: High blood pressure is a strong risk factor for cardiovascular disease. The Joint National Committee on High Blood Pressure (JNC) identified a new category of blood pressure in adults termed pre-hypertension. Keeping BP below 120/80 mm Hg may provide important health benefits later in life. *Methods:* Total 201 subjects were selected from general population with the age between 18-70 years. Blood pressure was measured with mercury sphygmomanometer and prehypertension was classified according to JNC 7. 101 subjects were found to be prehypertensives and 100 were normotensives. Two-dimensionally guided M-mode echocardiography was performed by standard methods. *Results:* BMI and BSA were elevated in prehypertensives. HR, SBP, DBP, PP & MAP were significantly elevated ($p<0.001$) in prehypertensives compared to normotensives. A statistically significant difference was noted in LVIDd, LVIDs, PWT, LVM and LVMI between two groups in male populations whereas in female populations only LVM and LVMI were statistically significant. *Conclusion:* Such findings carry prognostic implication. Early diagnosis of prehypertension will help to take necessary preventive measures to reduce cardiac morbidity and mortality in later period.

Author's Affiliations:
[1]Assistant Professor [2]Associate Professor, Department of Physiology, Varun Arjun Medical College & Rohilkhand Hospital, Shahjahanpur, Uttar Pradesh 242307, India.
[3]Ex. Professor, Department of Physiology
[4]Professor, Department of Cardiology, Shri Ram Murti Smarak Institute of Medical Sciences, Bareilly, Uttar Pradesh 243001, India.

Corresponding Author:
Sudhir Modala
Associate Professor, Department of Physiology, Varun Arjun Medical College & Rohilkhand Hospital, Shahjahanpur, Uttar Pradesh 242307, India.
E-mail: msudhir99@gmail.com

Received on: February 28, 2018
Accepted on: April 02, 2018

Keywords: Cardiovascular Risk; Prehypertension; Echocardiography; LVM; LVMI.

Introduction

Prehypertension (PHT) is a precursor of clinical hypertension and is closely related to cardiovascular diseases[1]. The term PHT was adopted in May 2003 by the Seventh Report of the Joint National Committee on Prevention, Detection, Evaluation and Treatment of High blood Pressure (JNC-7) [2]. According to JNC – 7, PHT is defined as the systolic BP between 120–139 and diastolic BP of 80 – 89 mm of Hg not only to emphasize the excess risk associated with BP in this range, but also to focus increased clinical and public health attention on prevention [2]. Individuals with PHT have a greater risk of developing hypertension later in their life and is associated with higher risk of cardiovascular disease (CVD) [3]. There is a continuous increase in mortality from both stroke and ischemic heart disease from BP of 115/75mmHg, with a twofold increase in cardiovascular death in those with 20mm Hg higher systolic pressure or a 10mmHg higher diastolic pressure, a level well within the range of PHT [4].

Increasing trend of PHT is a worldwide phenomenon [5]. PHT is more prevalent than hypertension [6]. In India, prevalence of PHT respectively, was significantly greater in South India (Trivandrum 31.9%) and West India (Mumbai: 29.1%) compared to North India (Moradabad: 24.5%) and East India (Kolkata: 22.4%) [7].

Left Ventricular Mass (LVM) increases with increase in blood pressure. It might be due to increase in the pressure load persistently. Increase in LVM might be physiological or pathological. Several factors which are associated with increased LVM have been identified, which include age, gender, blood pressure, body size, physical activity and blood

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viscosity [8]. However, neuro-humoral and genetic factors have also been implicated [9]. LVM progressively increases during aging [10], which is reported in normotensives, prehypertensive and hypertensives. The age associated LVM increment may be attributed to the physiological increase in body size and blood pressure [11] or to pathological hypertrophic changes which are caused by an increased overload. Obesity has been implicated as important determinants of LVM in most of the population based studies [12]. Such early morphological and sometimes functional changes in heart can be detected by 2 Dechocardiography.

In prehypertensive state, these changes are generally reversible if it is diagnosed in early state. The change can be reverted back to the normal LV structure and function by simple life style modification and low salt diet, DASH diet, and increase in physical activity, moderation of alcohol intake. Hence, early diagnosis can help in early institution of corrective measures and preventing long term complications.

Materials and Methods

The study was conducted in the department of physiology and cardiology simultaneously at SRMS – IMS, Bareilly (UP). The study was approved by institutional ethics committee and informed written consents were obtained from subjects. A total of 201 subjects were included in study whose age ranged from 18–70 years in which 101 asymptomatic Subjects attending the cardiology OPD accidently detected prehypertension were randomly taken who came for executive cardiac health check up. Both males and females were considered in the study. Study population has 49 normotensive male and 51 normotensive females. Prehypertensives groups have 54 males and 47 females.

Exclusion Criteria

Subjects with Diabetes mellitus (DM), obesity, respiratory disease, kidney disease, angina, thyroid disorder, & athletes were excluded from the study.

Subjects were assigned to two different groups. The anthropometric parameters as well as BP, Pulse were recorded. Subjects were briefed about the 2D – echo. Echocardiography was done in each subject to rule out any cardiac abnormality and to study the effect of prehypertension on the left ventricular structure and function using *Siemen's ACCUSON Model no.KT-LM170SDS* (Made in Germany).

Left ventricular mass (LVM) was calculated at end-diastole by using the American Society of Echocardiography (ASE) convention [13]. LV mass (ASE) = 0.8 (1.04 ([LVIDD + PWTD + IVSTD] 3-[LVIDD] 3))+ 0.6 g. Where, LVIDd = Left ventricular internal diameter in diastole, PWT = Posterior wall thickness in diastole, IVSTd = Interventricular septal thickness in diastole. LV mass index was measured as follows: LVM divided by body surface area (LVM/BSA, g/m^2). A second index was calculated by height (LVM/ht, g/m) or $height^{2.7}$ ($LVM/ht^{2.7}$, $g/m^{2.7}$) [14].

Statistical Analysis

Parameters were recorded and mean±SD was calculated using Microsoft Excel 2010 between the two groups. Unpaired t-test was used to find the significance of difference between the two groups.

Results

Table 1: Demographic Profile of Male Study Group

Variables	Normotensives (n=49) Mean±SD	Prehypertensives (n=54) Mean±SD	p - value
Age (yrs)	45.55±13.27	44.03±11.84	0.5
Height (metre)	1.73±0.05	1.72±0.05	0.3
Weight (Kg)	71.98±6.42	70.11±6.43	0.1
BMI (Kg/m2)	22..92±1.19	23.26±1.19	0.7
BSA (Kg/m2)	1.86±0.11	1.84±0.10	0.3

Table 2: Demographic Profile of Female Study Group

Variables	Normotensives (n=51) Mean±SD	Prehypertensives (n=47) Mean±SD	p - value
Age (yrs)	42.0±11.06	42.0±12.83	1
Height(metre)	1.55±0.04	1.54±0.06	0.3
Weight (Kg)	54.18±5.05	53.03±7.59	0.3
BMI (Kg/m2)	22.58±1.87	23.05±1.36	0.1
BSA (Kg/m2)	1.52±0.08	1.50±0.13	0.3

Table 3: Blood Pressure & Pulse profile of Male Study Group

Variables	Normotensive (n= 49) Mean±SD	Prehypertensive (n=54) Mean±SD	P-value
Pulse(beats/min)	76.55±5.10	83.94±6.06	<0.0001
SBP (mm of Hg)	115.44±3.60	131.12±4.52	<0.0001
DBP (mm of Hg)	74.90±3.19	84.99±2.26	<0.0001
PP (mm of Hg)	40.54±2.46	46.14±3.64	<0.0001
MAP (mm of Hg)	88.41±3.12	100.37±2.69	<0.0001

Table 4: Blood Pressure & Pulse profile of Female Study Group

Variables	Normotensives (n=51) Mean±SD	Prehypertensives (n=47) Mean±SD	P-value
Pulse (beats/min)	74.25±4.58	78.74±5.81	<0.0001
SBP (mm of Hg)	112.26±3.62	128.81±4.80	<0.0001
DBP (mm of Hg)	72.63±3.33	83.90±2.52	<0.0001
PP (mm of Hg)	39.63±2.10	44.91±3.37	<0.0001
MAP (mm of Hg)	85.54±3.28	98.86±3.07	<0.0001

Table 5a: Echocardiographic Parameters in the Male Study Group

Variables	Normotensives (n=49) Mean±SD	Prehypertensives (n=54) Mean±SD	P- value
LVIDd (mm)	40.10±4.99	42.68±4.35	<0.006
PWT (cm)	9.85±1.19	10.44±1.88	<0.06
IVSTd (mm)	10.61±1.52	11.16±1.59	<0.07
LVM (gm)	136.90±40.72	163.55±50.77	<0.004
LVMI (gm/$m^{2.7}$)	30.44±8.67	37.73±11.24	<0.0004
LVMI (gm/m^2)	73.42±20.93	88.93±26.31	<0.001
LVMI(Ht)	78.37±22.71	94.92±28.78	<0.001

Table 5b: Echocardiographic Parameters in the Female Study Group

Variables	Normotensives (n=51) Mean±SD	Prehypertensives (n=47) Mean±SD	P- value
LVIDd (mm)	38.18±4.22	39.17±4.89	0.2
PWT (cm)	9.31±1.06	9.66±1.47	0.1
IVSTd (mm)	9.96±1.11	10.43±1.54	0.08
LVM (gm)	142.84±23.88	150.25±19.77	0.09
LVMI(gm/$m^{2.7}$)	38.25±5.10	39.71±5.92	0.1
LVMI (gm/m^2)	88.85±11.80	92.91±8.29	0.05
LVMI (Ht)	90.79±7.31	91.37±10.10	0.7

Discussion

PHT is a major risk factor that doubles the risk of cardiovascular disease (CVD) independent of progression to overt hypertension globally. Individuals with prehypertension have a greater risk of developing hypertension later in their life. It has been further found that it causes various structural and functional abnormalities of the heart, especially alteration in Left Ventricular (LV) geometry. The most important means of preventing the prehypertension to hypertensive state which may lead to adverse cardio-vascular events is early identification, lifestyle and dietary modification before complications develop. BMI in the prehypertensives group are in overweight category at risk in both male and female subjects according to classification of weight by BMI in adult Asians (The Asia pacific perspective) [15]. Wang W J et al. [16] also stated a positive correlation between BMI and hypertension. They have an increase in intravascular volume and cardiac output to supply the increase in metabolic demands related to increased fatty tissue. The findings of their suggested need of monitoring the anthropometry of obese children as well as children of hypertensive parents. Monika et al. [17] reported 11% of the prehypertensive males were having BMI of 25 or more while it was 2% for prehypertensive females.

Although hypertension is a well-documented independent predictor of elevated LVMI [18,19], few studies have shown the relationship between PHT and structural changes in the LV.

Our study demonstrated a strong relationship between PHT and LVMI when compared to normal BP, even after adjustment for age, gender, race, and BMI.

In prehypertensives males, there is a significant difference between the LVIDd, IVSTd, PWT, LVM and LVMI. Whereas in prehypertensives females, there is a significant difference between the LVM and LVMI (g/m2) whereas LVIDd, IVSTd, PWT shows an increased value but the difference is not significant. These parameters are the indices for the LVH. In addition, increase in salt intake and also a greater sympathetic activity are the mechanisms participating in the genesis of left ventricular hypertrophy. Elevated LVM is a well described independent risk factor for adverse CV events and is associated with development of depressed left ventricular (LV) systolic function, a precursor of heart failure. In case of prehypertensives, it may be due to early stage of hyperdynamic circulation & LV wall stress. Increased LV filling which was due to volume overload or elevated venous return, which was responsible for elevated SV but not disturbing normal systolic function. In the early stages of prehypertension, there occurs elevation of adrenergic tone typically characterized by hyperkinetic status [20].

Manios et al. [21] analyzed the impact of PHT on LVM. They found a statistically significant association between prehypertensives and LVM ($p = 0.03$) compared to normotensive patients after adjustment for baseline characteristics. Stabouli et al[22] shows that the prevalence of LVH was significantly higher in the prehypertensive compared to normotensive subjects, and was equal to that of the hypertensive subjects. Hypertension and prehypertension in children and adolescents were associated with pathologically elevated LVMI values. Our study supports this finding. Bajpai et al. [23] found that the LVM and LVMI were increased in case of prehypertensive males but were significantly increased in case of prehypertensive females. LVMI was also on the greater side. We were able to establish the importance of PHT category to the increased risk of developing future CVD. Left ventricular hypertrophy (LVH), measured by LVMI, and has been identified as the most powerful risk factor for future cardiovascular events causing morbidity and mortality [24].

Conclusion

Prehypertension is an intermediate stage between normal BP and hypertension. Prehypertension is more prevalent than hypertension. In conclusion, this data provides evidence of increased LVM and LVMI in prehypertensive patients. In prehypertensive state, these changes are generally reversible if it is diagnosed in early state. The person can be reverted back to the normal LV structure and function even by simple life style modification, low salt diet, DASH diet, and increase in physical activity, moderation of alcohol intake. Health care providers and health planners should be made aware of the large numbers of persons at increased risk for cardiovascular disease and steps should be taken to identify and treat modifiable risk factors in such persons. At the very least a proper diet and regular exercise should be recommended in these category of people.

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