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Research Article

PREVALENCE AND DETERMINANTS OF ECHOCARDIOGRAPHIC LEFT VENTRICULAR HYPERTROPHY AMONG HYPERTENSIVE PATIENTS IN A TERTIARY CARE HOSPITAL

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ABSTRACT

Objectives: This cross-sectional study was conducted during the year 2014–15 to determine the prevalence, pattern, and factors associated with left ventricular hypertrophy (LVH) among hypertensive patients attending a tertiary care hospital.

Methods: A total of 400 eligible adult patients having essential hypertension were included in this study. After obtaining informed consent, all participants were examined with echocardiography and relevant information was collected using a well-structured questionnaire.

Results: The mean age of study population was 52.3 ± 12.8 in years. Mean systolic (SBP) and diastolic blood pressure (DBP) was 149.8 ± 11.2 and 94.7 ± 4.9 mmHg, respectively. Among the study participants, 266 (66.5%) had LVH and concentric hypertrophy was the predominant (64.3%) LV geometric pattern. Multivariate logistic regression revealed that obesity, SBP, and DBP had significant positive association with LVH ($p<0.05$).

Conclusion: Liberal use of echocardiography in hypertensive patients could be useful in early diagnosis of LVH and guiding treatment decision. There should be emphasis on controlling SBP, DBP, and body mass index of hypertensive patients so that further cardiovascular complications can be prevented.

Key words: Left ventricular hypertrophy, Hypertension, Echocardiography, Geometric pattern.

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INTRODUCTION

Cardiovascular diseases (CVDs) constitute one of the major causes of death and disabilities in the world. An estimated 17.7 million people died from CVD in 2015, representing 31% of all global deaths. Of the 17 million premature deaths (under the age of 70) due to non-communicable diseases in 2015, 82% are in low- and middle-income countries, and 37% are caused by CVD [1]. It is predicted that there will be a 60% rise in hypertensive adult patients from 972 million in 2000 to 1.56 billion in 2025 worldwide [2]. Hypertension is a powerful predictor of cardiovascular morbidity and mortality with significant disability [3-5] and directly responsible for 57% of all stroke deaths; 24% of all coronary heart disease deaths in India [6]. Blood pressure reduction is highly efficacious in protecting patients against stroke and stroke recurrence, especially on long-term basis [7].

Left ventricular hypertrophy (LVH) is one of the earliest manifestations of organ damage among hypertensive patients and is a strong independent predictor of cardiovascular mortality and morbidity [8-11]. It has been shown in various studies that the incidence of LVH increases with age, obesity, gender, and blood pressure [12-16]. The relationship between LV mass and the degree of obesity has also been demonstrated by the Framingham study. Early diagnosis of LVH, risk stratification, and aggressive treatment is essential to prevent cardiovascular morbidity and mortality [17]. It has been reported that assessment of cardiovascular risks among hypertensive patients are inadequate [18] and information regarding LVH in hypertensive patients is scarce, especially in this region. In this context, the present study was conducted with the aim to assess the prevalence and pattern of LVH and determine its associated factors among hypertensive patients.

METHODS

This is a cross-sectional descriptive study conducted at IMS and SUM Hospital, Bhubaneswar, in the Department of Cardiology/Physiology including 400 hypertensive patients who attended cardiology OPD from May 2014 to April 2015. All the study participants were explained about the nature and purpose of the study; informed consent was obtained before their participation in the study. All eligible study individuals were examined with echocardiography and relevant information was obtained using a well-structured questionnaire. Assuming the prevalence of echocardiographic LVH as 45% [19] with absolute precision 5% and 95% confidence interval, the sample size was calculated as 380. However, we included 400 patients in our study. The study was approved by the Institutional Ethics Committee of the authors' institution and all procedures followed were in accordance with appropriate ethical guidelines.

Inclusion criteria

Adults' ≥18 years of age diagnosed to have essential hypertension with or without medication and willing to participate in the study.

Exclusion criteria

The presence of known cardiac diseases including valvular heart disease, coronary artery disease, conduction abnormalities; systemic diseases such as diabetes mellitus, chronic kidney disease, chronic obstructive pulmonary disease, tuberculosis, hepatic disease, and cancer.

Height of the study subjects was measured using stadiometer and the reading was taken to the nearest 0.5 cm. Weight was measured using a weighing machine with the subjects wearing only light clothing. Body mass index (BMI) was calculated as weight in kilogram divided by the square of

the height in meters (kg/m^2). BMI cutoff values for Asians as per the NICE guideline were followed to define obesity as having BMI ≥27.5, overweight with BMI 23–27.5 kg/m^2, normal 18.5–23 kg/m^2, and underweight <18·5 kg/m^2 [20]. The body surface area (BSA) was determined by Dubois formula (BSA =0.007184 × Height$^{0.725}$ × Weight$^{0.425}$) [21]. Blood pressure was measured using standardized mercury sphygmomanometer to determine brachial artery systolic (SBP) and diastolic blood pressure (DBP). The blood pressure was measured by a cardiologist after 5 min rest in erect sitting posture over the left upper arm of the study subjects. The first and fifth Korotkoff sounds were taken as SBP and DBP. The blood pressure ≥140/90 mmHg was considered to be hypertensive according to JNC7 criteria. The blood pressure was taken as mean of two readings measured under standardized conditions. 2D and M-mode echocardiography was performed in all the study participants using a commercially available GE Vivid E9 with XD clear (echocardiography machine equipped with a broadband transducer) in supine left lateral decubitus position. All echocardiographic measurements were performed by a cardiologist. Readings were taken as per the American Society of Echocardiography (ASE) recommendation. The M-mode derived parasternal view was used to assess the chamber and wall dimensions of the left ventricle and left atrium (LA). The ASE recommended Devereux formula was used for the estimation of the LV mass (LVM) from LV linear dimensions [LVM (g) = 1.04 ((LVIDd + IVSd + LVPWd)3 – LVIDd3) – 13.6, where, LVID = LV internal diameter at end diastole, IVSD = interventricular septal wall thickness at end diastole, LVPWD = LV posterior wall thickness at end diastole].

LVM index (LVMI) was obtained as a ratio of LVM and BSA (LVM/BSA). Gender-specific and indexation of LVM was used to diagnose LVH using the defining criteria for men and women, respectively [22]. LVH was defined by LVMI thresholds of 125 g/m^2 for men and 110 g/m^2 for women. The relative wall thickness (RWT) was calculated using the formula ×2 LVPWD/LVID and considered as increased when it is >0.42 [23]. RWT and LVMI were used to define LV geometric patterns. LV geometry was divided into four patterns based on LVMI and RWT values; normal geometry: Normal LVMI and RWT ≤0.42, concentric remodeling: Normal LVMI and RWT >0.42, eccentric hypertrophy: Increased LVMI and RWT ≤0.42, and concentric hypertrophy: Increased LVMI and RWT >0.42. LA size was determined with parasternal long axis view at end systole along its greatest dimension.

Statistical analysis

All the data were compiled and analyzed using SPSS version 21.0 software and values were expressed as mean, standard deviation, proportion, odds ratio, and 95% confidence interval. Univariate and multivariate logistic regression analyses were used to explore the associations between LVH as dependent variable and sociodemographic and individual characteristics as independent variables. The variables found to have p<0.2 in univariate analyses were entered into multivariate model. p<0.05 was considered as statistically significant.

RESULTS

Of 400 study respondents, 247 (61.7%) were male and rest were female. The mean age of study population was 52.3 ± 12.8 years. The mean BMI was 26.7 ± 4.6 and the mean BSA was 1.6 ± 0.2. The mean SBP and DBP was 149.8 ± 11.2 and 94.7 ± 4.9 mmHg, respectively.

The sociodemographic characteristics of study population were shown in Table 1. Majority (50.7%) of respondents belongs to age range of 41–60 years and 30.2% were >60 years old. About 331 (82.7%) respondents were overweight or obese. It was observed that almost two-third of hypertensive patients had LVH. Variables such as BMI, SBP, DBP, and left atrial diameter were found significantly associated with LVH in hypertensive patients.

Table 2 summarizes the LV geometric pattern among the hypertensive study population. Abnormal LV geometry was seen in almost all study subjects (98.7%). Concentric hypertrophy was the predominant (64.3%) pattern followed by concentric remodeling (32.3%) among the hypertensives.

Multivariate analysis showing associations of variables with LVH is given in Table 3. Left atrial diameter lost its significance, whereas BMI, SBP, and DBP retained their significance in predicting LVH among the hypertensive patients.

DISCUSSION

Our study revealed that 66.5% of hypertensive patients had developed LVH. This figure was comparable to the prevalence of 58.3–75.3% [24-26] in various studies which used the same LVH criteria as in our study. It was higher compared to many other studies, which reported prevalence of LVH between 26.8% and 46.0% [27-30]. As for LV geometric patterns, we observed that the concentric pattern was more prevalent among hypertensive patients. Different studies have shown the association of incremental risk of abnormal geometric patterns, with highest in concentric hypertrophy, followed by eccentric hypertrophy and concentric remodeling [31-34]. The study by Patel et al. and Potu et al. revealed that concentric remodeling (38.5–52.1% and 30%) was the most common abnormal geometry in the hypertensive population followed by concentric hypertrophy (15.3–28.9% and 14%) and eccentric hypertrophy (3.99–10.3% and 11%) which was the least common type of abnormal geometry [35,36]. Studies showed that eccentric hypertrophy was the most common abnormal geometry found in hypertensive population by Adebiyi et al., Cuspidi et al., and Wachtell et al. [19,37,38] whereas Akintunde et al. found that majority of hypertensive subjects had concentric remodeling [39]. There is global and cellular change in the ventricular shape and function in cardiac remodeling. This follows chamber dilation, interstitial and perivascular fibrosis which lead to chronic heart failure [40]. There is an increasing body of evidence and controversies about the role of gender in developing LVH [12,13,15,19]. Our study did not show significant difference between gender and LVH.

Previous studies reported that patients with obesity had a higher risk of developing LVH [40-45]. In this study, obesity was found to be one of the predictors for developing LVH among hypertensive patients. The odds of developing LVH were twice in an obese patient compared to a patient who had normal weight. Further, the odds of developing LVH were 1.4 times higher for an obese patient compared to an overweight patient, but this is statistically insignificant. Kathrotia et al. also showed similar trend in association of obesity with LVH [46]. This might be related to obesity cardiomyopathy which is characterized by the presence of LVH [47]. We also observed that SBP and DBP were two independent determinants for LVH which indicates that reduction of SBP or DBP would significantly regress LVH. This finding is supported by various literature [48-50]. Thus, blood pressure management targeting both SBP and DBP would be useful in preventing the development of LVH. The left atrial enlargement is a predictor for overall cardiovascular risk and frequently found in hypertensive patients as reported by Cuspidi et al. [19]. This abnormality was strongly related to LVH [51-53]. This study showed that LVH was 1.4 times more likely among hypertensives with one unit increase in left atrial diameter (p=0.088). For this reason, European Society of Cardiology strongly recommends the measurement of left atrial size in echocardiography.

Our study few limitations. First, the result of the study may not be generalized to other settings since it was limited to one tertiary care hospital in Bhubaneswar. Second, causal association of the factors with the development of LVH cannot be established due to cross-sectional nature of the study. However, in spite of these limitations, the findings of our study might be useful in developing strategies to identify LVH among hypertensive patients.

CONCLUSION

LVH is the alarming and significant rising condition in hypertension. The prevalence of LVH was high in hypertensive patients as found in our study. Efforts should be made for early detection of LVH with liberal use of echocardiography in these patients which will guide appropriate

Table 1: Sociodemographic characteristics of study population by echocardiographic LVH status (n=400)

Variable	No LVH n=134 (%)	LVH n=266 (%)	p value
Age in years			
20–40	32 (42.1)	44 (57.9)	0.164
41–60	61 (30.0)	142 (70.0)	
>60	41 (33.9)	80 (66.1)	
Gender			
Male	75 (30.4)	172 (69.6)	0.091
Female	59 (38.6)	94 (61.4)	
BMI			
Normal	35 (50.7)	34 (49.3)	0.000
Overweight	70 (38.3)	113 (61.7)	
Obesity	29 (19.6)	119 (80.4)	
Mean age in years	50.69±14.09	53.12±12.12	0.353
SBP (mmHg)	144.01±6.49	152.77±11.89	0.000
DBP (mmHg)	92.10±3.23	96.01±5.14	0.000
BMI (Kg/m^2)	25.13±3.63	27.49±4.79	0.000
Left atrial diameter (cm)	3.24±0.63	3.49±0.64	0.000
AV cusp (cm)	1.57±0.26	1.57±0.26	0.939

LVH: Left ventricular hypertrophy, SBP: Systolic blood pressure, DBP: Diastolic blood pressure, AV cusp: Atrioventricular cusp

Table 2: LV geometric patterns among the study population (n=400)

Geometric pattern	n (%)
Normal	05 (1.3)
Concentric remodeling	129 (32.3)
Eccentric hypertrophy	09 (2.3)
Concentric hypertrophy	257 (64.3)

LV: Left ventricular

Table 3: Multivariate analysis showing determinants of LVH

Variable	Odds ratio	95% CI	p value*
Age in years			
20–40	1.02	0.51–2.04	0.956
41–60	1.63	0.93–2.87	0.090
>60	1		
Gender			
Male	0.78	0.46–1.30	0.340
Female		1	
BMI			
Normal	0.47	0.23–0.98	0.043
Overweight	0.69	0.39–1.22	0.199
Obesity	1		
SBP	1.10	1.04–1.15	0.000
DBP	1.11	1.01–1.22	0.027
Left atrial diameter	1.41	0.95–2.09	0.088

*p<0.05 is considered as statistically significant, CI: Confidence interval. LVH: Left ventricular hypertrophy, SBP: Systolic blood pressure, DBP: Diastolic blood pressure, BMI: Body mass index

treatment decision, and thus further cardiovascular complications can be prevented.

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CONFLICT OF INTEREST

All the authors hereby declare that there is no conflict of interest.

AUTHOR CONTRIBUTIONS

All authors have made substantial contributions to the work reported in the manuscript. Anugya Aparajita Behera: Conception and designing of the study, data collection, data analysis and interpretation, drafting the article, critical revision of the article, final approval of the study to be published. Dr. Priyambada Panda: Drafting the article, critical revision of the article, final approval of the study to be published. Dr. Dipti Mohapatra: Data analysis and interpretation, drafting the article, critical revision of the article, final approval of the study to be published. Dr. Suresh Kumar Behera: Data collection, data analysis and interpretation, drafting the article, critical revision of the article, final approval of the study to be published. Dr. Arati Mohanty: Conception and designing of the study, drafting the article, critical revision of the article, final approval of the study to be published.

AUTHORS CONTRIBUTION

All authors have made substantial contributions to the work reported in the manuscript. Anugya Aparajita Behera: Conception and designing of the study, data collection, data analysis and interpretation, drafting the article, critical revision of the article, final approval of the study to be published. Dr. Priyambada Panda: Drafting the article, critical revision of the article, final approval of the study to be published. Dr. Dipti Mohapatra: Data analysis and interpretation, drafting the article, critical revision of the article, final approval of the study to be published. Dr. Suresh Kumar Behera: Data collection, data analysis and interpretation, drafting the article, critical revision of the article, final approval of the study to be published. Dr. Arati Mohanty: Conception and designing of the study, drafting the article, critical revision of the article, final approval of the study to be published.

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