World Heart Journal
Volume 6, Number 3

ISSN: 1556-4002


# Association of Left Ventricular Hypertrophy in Patients with Hypertension

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## Abstract

*Background*: Left ventricular hypertrophy (LVH) increases the risk of ischemic heart disease, stroke, and sudden cardiac death in patients with hypertension. The present study aims to determine the association of LVH in essential hypertensive patients by electrocardiography and echocardiography. *Subjects and methods:* A case study was carried out in a primary and secondary care Research Centre, during the period from 01 March,2013 to 31st August 2013. Hypertensive patients (n=121) above 18 years, with electrocardiographic criteria of LVH were included in this study. *Results:* A total 121 cases were studied. Majority of the study population was male (51.2%) illiterate (50.4%) farmers(43.5%), whereas among females, they were housewife (94.9%). LVH by echocardiography was diagnosed among 51.2%.Target organ damage was observed among 52.1% of subjects which was significantly higher among LVH patients (72.58%) compared to subjects without LVH (52.1 vs 23.72%,P = 0.00005441). There was no significant difference in the duration of hypertension in development of LVH (8.1% in those duration of hypertension >10 years and 53.2% in those with duration of hypertension 5-10 years). But frequency of LVH increases with the increase in blood pressure (from control to grade 1 to severe hypertension) (p value 0.00003302).Majority of the of the LVH patients(91.9%) had uncontrolled blood pressure. *Conclusion:* Echocardiogram appears to be more sensitive for diagnosis of LVH than electrocardiogram and uncontrolled blood pressure is the major cause of LVH in essential hypertension.

***Keywords:*** LVH, echocardiography, essential hypertension

## Introduction

Left ventricular hypertrophy (LVH), is an important complication of hypertension due to target organ damage which has been associated with increased morbidity and mortality. [1,2] LVH can be evaluated by a 12-lead electrocardiogram and/or echocardiography (ECHO). LVH defined by ECG

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(ECG-LVH) has been evaluated using standard voltage criteria reported by Sokolow and Lyon (SL) [3] and more recently using the Cornell product (CP) criteria [4] However, in 1949, the technology of echocardiography was not developed to make a final diagnosis of LVH. LVH detected by CP (CP-LVH) may have a higher sensitivity for the presence of LVH compared to evaluation by echocardiography (Echo-LVH) by the Sokolow-Lyon criteria (SL-LVH). [5] CP-LVH and SL-LVH were independently associated with Echo-LVH [6] and with stroke events, cardiovascular morbidity, and mortality in subjects with hypertension [7]. A marked increase in prevalence of hypertension (from 11.3% to 17.9%) was observed in Bangladesh from 1999 to 2010. [8,9] In Rangpur division (Northern part) of Bangladesh, prevalence of hypertension and pre-hypertension is 33.3% and 29.9% respectively. [10] Because of the high prevalence of this condition and the increased morbidity and mortality associated with this condition, the economic cost of hypertensive disease was estimated at $76.6 billion in 2010. [11]

Hypertension is a major determinant of LV hypertrophy and is associated with increased prevalence of LV systolic dysfunction. [12] However, global LV ejection fraction (EF), a measure of LV chamber function appears to be highly useful as an indicator of LV systolic dysfunction, could be normal, despite segmental WM abnormalities, especially when EF is estimated from linear echocardiographic LV dimensions at mid-cavity level, [13] or from single-plane contrast ventriculograms [14]. This study determined the association of left ventricular hypertrophy in patients with essential hypertension in Rangpur Medical College & Hospital, Rangpur and Hypertension and Research Centre, Rangpur.

## Methods and Subjects

This case control study is being carried out at Hypertension and Research Centre, Rangpur and department of Medicine, Rangpur Medical College Hospital. All the patients with hypertension with ECG criteria of LVH and radiological criteria of increased heart size, were included in this study.

**Sample size:** Sample size was calculated using the following statistical formula: $n=z^2pq/d^2$**.** Here, n=sample size, P=prevalence of LVH(Frank) in essential hypertension in adult population is 33.5%=0.335, (As the true prevalence of LVH in adult population is not known in Bangladesh, hence other studies were considered [14]. This study showed that the prevalence of LVH was 0.335) q=1-p=1-0.335=0.665.Z=1.96 (at 95% confidence level), d= acceptable error or precision in the estimate of "p" is 0.05 (5%).

Calculation: $n= Z^2pq/d^2$
$= (1.96)^2 \times 0.335 \times 0.665 /(0.05)^2$
$=3.8416 \times 0.2227 /0.0025$
$= 0.8555/0.0025$
$= 342.2$

Therefore, the required sample size is n= 342. However, poor financial resources allowed us to study only 121 randomly selected subjects, in this study. Rest subjects were requested to come follow up for future study.

**Inclusion criteria:** Hypertension with ECG criteria of LVH. 2.Age 18 years and above.

**Exclusion criteria:** Subjects unwilling to take part in the study and those with Secondary hypertension.

### *Data collection*

After informed written consent, blood pressure was measured by auscultatory method (according to JNC-7), using the validated aneroid sphygmomanometer. All the participants were requested to take rest for ten minutes before measuring the blood pressure. The individual was seated in a chair with his back supported and his arms bared and supported at heart level and was refrained from the use of tobacco in any form or ingestion of caffeine 30 minutes preceding the measurement. Two separate readings were taken at an interval of minimum three minutes. If systolic blood pressure differed >10 mm of Hg and diastolic >5 mm of Hg, then 2 more readings were taken. The average of the two or 4 readings were used to record the blood pressure. Systolic blood pressure measured at the appearance of the *Korotkoff* sounds (Phase I) and

Diastolic BP was taken at the point of disappearance of the sounds (Phase V). The socio-demographic characterestics, BMI, knowledge about hypertension, (in diagnosed hypertensive) was collected in a pre-designed, pretested questionnaire. Random blood sugar, serum creatinine, x ray chest, 12 lead electrocardiogram and echocardiogram were obtained in all the study subjects.

### *Operational definitions*

**1. LVH:** ECG-According to voltage criteria any of

S in V1+R in V5 or V6 ≥ 35mm

R or S in limb leads ≥ 20mm.

S in V1 or V2 ≥ 30mm.

R in V5 or V6 ≥ 30 mm.

Echocardiogram-

In 2D echocardiogram LV wall thickness in diastole > 12 mm is diagnostic of LVH. [19]

**2. BP Scheme for Adults (in mm Hg)**

Normal: systolic BP <120 and diastolic BP <80

Prehypertension: SBP 120-139 or DBP 80-89

Hypertension SBP ≥140 mm of Hg and/or ≥90 mm of Hg

Grade 1 hypertension: SBP 140-159

or DBP 90-99

Grade 2 hypertension: SBP ≥160 or DBP ≥100

Severe hypertension SBP ≥180 and/or ≥110

**3. Essential hypertension**

Those who had no secondary cause of hypertension. Current smoker-those who smoked at least within last 6 months.

### *Statistical Analysis*

The desired variables are processed, edited and analyzed by SPSS windows version 17.0. The socio-demographic data of the study population were expressed in frequency distribution and their observed difference was tested by one sample‘t’ test and ‘chi square’ test. P value <0.05 and two tailed t test was considered as statistically significant with the 95% confidence interval.

## Results

This study included a total of 121 patients of essential hypertension with LVH (by ECG criteria). Males and females were comparable (51.2% vs 48.8%). Mean age of the study population was 53.94 years (SD±13.64). Mean BMI was 21.39 Kg/M2 (range 14.75-28.58 Kg/m2). (Table 1 shows the socio-demographic characteristics of the study population). Among the modifiable risk factors of hypertension, 30.6% were current smoker and the remaining 69.4% nonsmoker. All the smokers were male, having low level of education (under graduate) 62.2%. 6.6 %( 8) of the study population had diabetes mellitus.

**Table 1. Socio-demographic characteristics of the study people at baseline**

| Variables | Frequency(n-121) | Percentage (%) |
|---|---|---|
| Mean age (SD)<br>Age range, years | 53.94 years (SD±13.64)<br>22-90 | |
| Sex, Male<br>Female | 62<br>59 | 51.2%<br>48.8% |
| Education<br>Illiterate<br>Undergraduate<br>Graduate and above | <br>61<br>50<br>10 | <br>50.4%<br>41.3%<br>8.3% |
| Occupation<br>Housewife<br>Farmer<br>Service<br>Business<br>Others | <br>56<br>27<br>24<br>10<br>4 | <br>46.3%<br>22.3%<br>19.8%<br>8.3%<br>3.3% |

### *Target Organ Damage Of The Hypertensive*

Target organ damage was common (52.1%,n=63). (Table II).LVH was diagnosed in 62 (51.2%) by echocardiography. Among stroke patients, 68.2% (15) had LVH by echocardiogram. 81.3% (13) of the CKD patients had LVH (on echocardiogram). Among IHD patients, 81% (17) had LVH by echocardiogram.

Majority of the patients had grade 2 hypertension (45.5%) and severe hypertension was observed in 31.4%. Control blood pressure was present in only 7.4% of the patients. Grade 1 hypertension was significantly lower compared to grade 2 and 3 hypertension respectively (15.7% vs 45.5% and 31.4% (n=19 vs 55 and 38). Only 9 (7.4%) had controlled BP.

**Table 2. Target organ damage in the study population**

| Target organ | Number (%) |
|---|---|
| IHD | 21 (17.4%) |
| LVH (On Echocardiogram) | 62 (51.2%) |
| CKD | 16 (13.2%) |
| Stroke | 22 (18.2%) |

Among the LVH patient, blood pressure was controlled in only 8.15% (5) and blood pressure was uncontrolled in 91.9% (57) (p = 0001). Frequency of LVH increased with the increase level of blood pressure (from control to grade 1 to severe hypertension). (Figure I). (p = 0.00003302).

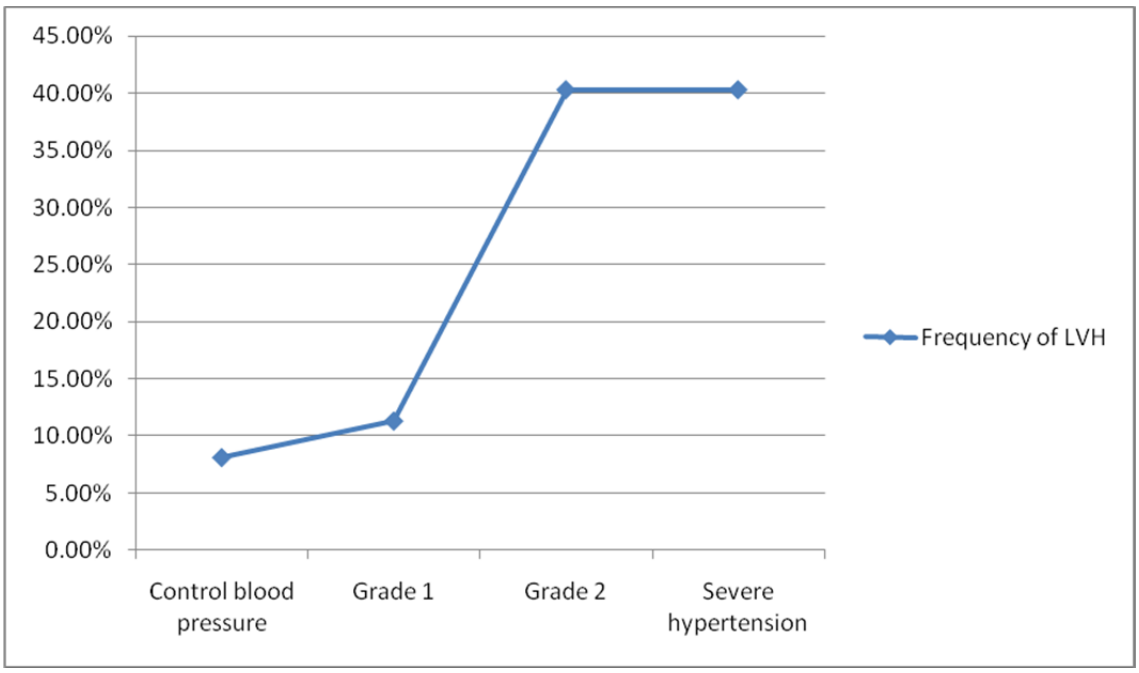


Figure 1.

### *Socio-Demographic and Clinical Characteristics of the LVH (On Echocardiography) Patients*

All patients had ECG criteria of LVH but LVH on echocardiography were present in 51.2% (62) patients. LVH patients were slightly older than those without LVH (55.98 vs 51.80 years). LVH was more more common in males, current smokers, having diabetes and longer duration of hypertension. (Table 3) There was no significant difference in BMI between two groups of patients. (21.40 Kg/M2 vs 21.37 Kg/M2). Ejection fraction was slightly lower in LVH patients than without LVH (EF 54.61 vs 57.29). Target organ damage (stroke, CAD, CKD) was much

higher in patients with LVH (72.58%) than in those without LVH (23.72%) (p =0.00005441).

**Table 3. Comparison of characteristics of patient with hypertension with LVH (echocardiography) and hypertension (n,%)**

| Points | Hypertension with LVH | Hypertension, no LVH |
|---|---|---|
| Male<br>Female | 34 (54.8%)<br>44.2% (28) | 28 (47.5%)<br>31 (52.5%) |
| Mean Age, years | 55.98 | 51.80 |
| Smoking | 22 (35.5%) | 15 (25.4%) |
| Diabetes mellitus | 6 (9.7%) | 2 (3.4%) |
| Chronic kidney disease. | 13 (21%) | 3 (5.1%) |
| Stroke | 15 (24.2%) | 7 (11.9%) |
| Systolic BP, mmHg<br>Diastolic " " | 168.31<br>99.52 | 162.12<br>95.17 |
| Cardiomegally,chest X-ray | 17 (27.4%) | 9 (15.3%) |
| Duration of hypertension<br><5 years<br>5-10 years<br>>10 years | <br>23 (37.1%)<br>33 (53.2%)<br>5 (8.1%) | <br>31 (52.5%)<br>27 (45.8%)<br>1 (1.7%) |

## Discussion

The presence of left ventricular hypertrophy in hypertensive patients, diagnosed by electro-cardiographic criteria, is associated with a threefold greater risk of mortality from cardiovascular disease compared to the risk associated with hypertension alone. [14,15] Echocardiographic LVH is also associated with increased risk of cardiovascular disease and death in hypertensive men'41 and in the general population [16]. The prevalence of left ventricular hypertrophy determined by echo-cardiography in hypertensive patients has been reported to be 23% to 48%. [16-17]

This study shows that LVH was present in 51.2% (n=62) of subjects, which was slightly higher compared to other studies [16-18]. This may be due to the fact that in this study, hypertensive patient with ECG criteria of LVH were enrolled. Other study [18] showed higher prevalence of LVH in elderly patients with well controlled hypertension which was not consistent with this study. It is possible that this difference may be due to the fact that in our study mean age of the LVH patients was 55.98 years and LVH was predominant in uncontrolled hypertensives than controlled hypertensives (P value 000). Our study has also shown that longer duration of hypertension is not a major factor for development of LVH. The frequency of LVH was only 8.1% in those who had duration of hypertension more than 10 years and majority (53.2%) of the LVH patients had duration of hypertension 5-10 years. However, frequency of LVH increases with the increased level of blood pressure (from control to grade 1 to severe hypertension) (p =0.00003302). Other studies from our Center, have shown that control rate of blood pressure was 20% [19] to 36.06% [10]. However, in the present study, blood pressure was control in only 7.4% of the patients. This may be due to irregular follow up and irregular administration of the antihypertensive drugs. Mondal et al. [20] have shown that 68.03% of the hypertensive patients drop out from the follow up due to ignorance. In other studies from South Asia, ECG changes among hypertensive patients have been observed which may be due to silent CAD and LVH [22-24].

In our study, target organ damage was found (Stroke, CAD, CKD) to be much higher compared to other study (48.8 vs 21.87%, p<0.001) [10]. Higher frequency of uncontrolled blood pressure and LVH may contribute to this high percentage of target organ damage. Hypertension has become as an important cause of premature mortality and morbidity due to its major etiologic role in the development of coronary artery disease (CAD), stroke and CKD. It has been well recognized that LVH is a potential risk factor in association with hypertension, which increases the risk of cardiovascular events, including mortality and morbidity from heart failure, atrial fibrillation, and sudden death [21]. Our study has shown that target organ damage (stroke, CAD, CKD) was much higher in patients with LVH than those without LVH (p = 0.00005441) and major cause of LVH was uncontrolled blood pressure. It is suggested that every attempt should be taken to control blood pressure of the hypertensive patients. In our study, smoking (30.6% vs 31.2 %) was comparable with another study [10] indicating that cessation of tobacco may be important for decreasing BPs and risk of CVDs. Blood pressure should be controlled to prevent development of LVH and subsequent complications of hypertension.

**The Limitation of this study** is that sample size was small.

**There was no conflict of interest.**

## Acknowledgments

The authors of this study are grateful to Professor M. A. Jalil Chowdhury, Professor Dr. Md. Mujibur Rahman, staff of Hypertension and Research Centre, Rangpur; Department of Medicine, RpMCH, Department of Medicine of Rangpur Community Medical College.

### *Contributions by the authors*

Dr. Ratindra Nath Mondal planned and supervised the study. Dr. Md. Jahedul Islam, Dr. Md. Ashraful Haque, ABM Mobasher Alam analysed the data. Dr. Shah Md.Sarwer Jahan, Dr. Md. Mahfuzer Rahman, Dr. Md. Kumruzzaman Sarker, Dr. Moni Rani, Muhammad Mahbub Hussain, Md. Haripada Sarkar, Md. Atiqul Islam helped to collect the data. Dr. B. D. Bidhu, Professor Dr. Md. Zakir Hossain, Professor Dr. Amaresh Chandra Shaha, Professor Ram B. Singh, Professor Dr. Md. Noor Islam helped in writing of the manuscript and presentation of the data.

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