



Research Article

## To Study the Role of Echocardiography in Assessing Hypertensive Heart Disease and Relating It with Duration of Hypertension

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### ABSTRACT

**Background:** Hypertensive heart disease (HHD) involves structural and functional changes in the heart due to chronic high blood pressure, a leading cause of morbidity and mortality globally. Echocardiography is crucial for evaluating heart changes in hypertensive patients, especially in detecting early signs of damage like left ventricular hypertrophy (LVH), diastolic dysfunction, and atrial enlargement, which can predict adverse cardiovascular outcomes. **Methods:** This cross-sectional study was conducted at the Sri Aurobindo Medical College and Postgraduate Institute, Indore, and involved 132 hypertensive patients over the age of 18. Participants were divided into two groups based on the duration of hypertension: less than 10 years (Group 1) and more than 10 years (Group 2). Clinical assessments, echocardiography, and other diagnostic tests (ECG, chest X-ray, and laboratory tests) were used to gather data. Statistical analysis was performed using SPSS software. **Results:** A significant difference was found between the two groups in echocardiographic parameters. Patients with longer hypertension duration (>10 years) had higher Left Ventricular End-Diastolic Diameter (LVEDD), Left Ventricular End-Systolic Diameter (LVESD), Right Ventricular Systolic Pressure (RVSP), and a lower Left Ventricular Ejection Fraction (LVEF). The prevalence of left ventricular hypertrophy (LVH), mitral regurgitation, and congestive heart failure (CHF) was notably higher in the >10 years group. Blood pressure was also significantly higher in patients with hypertension for more than 10 years. **Conclusion:** The study underscores the significant impact of prolonged hypertension on cardiac remodeling, as seen in echocardiographic and clinical parameters. Early detection and strict blood pressure management are crucial to prevent further progression of hypertensive heart disease and its associated complications

**Keywords:** Hypertensive Heart Disease, Echocardiography, Left Ventricular Hypertrophy, Blood Pressure, Cardiovascular Outcomes

### INTRODUCTION

Hypertensive heart disease (HHD) constitutes an array of physical and molecular changes in the heart due to sustained elevation of the arterial blood pressure. Hypertension is a major preventable risk factor related to the cardiovascular condition which has become a leading cause of morbidity and mortality in the world since it is a major contributor to heart disease, stroke and renal failures[1]. The untenable influx of chronically elevated blood pressure activates a waxing and waning hue of adaptive and maladaptive responses on the cardiovascular system such as left ventricular hypertrophy (LVH), diastolic dysfunction, left atrial enlargement, and eventually, heart failure[2,3].

Echocardiography is fast, cheap, and easily accessible imaging modality that has proved very critical in the evaluation of the hypertensive heart disease. Even though by and large it is seen as second line study after clinical and electrocardiographic assessment, echocardiography has the unique selling point of in vivo assessing cardiac morphology

and assessing functional defects in real-time[1,4]. It proves to be especially sensitive in early asymptomatic organ dysfunction including LVH and diastolic dysfunction, which constitute independent predictors of unpleasing cardiovascular outcomes[3,5]. Echocardiography can be used through traditional two-dimensional imaging and Doppler to measure chambers, thickness of their walls, mass of the ventricles, performance during systole and diastole, of valvular and pericardial status. The emerging modalities such as tissue Doppler imaging, three-dimensional echocardiography, and three-dimensional echocardiography; speckle tracking allow more detailed description of myocardial mechanics, which even further improve risk analysis and treatment of hypertensive individuals[1,6].

Length of hypertension is directly correlated to the severity and character of enlargement. The higher risks and severity of target organ damage when afflicted with prolonged exposure to higher blood pressure are augmented with LVH and diastolic dysfunction as well as an enlargement of the atria which can be diagnosed echocardiographically[4,5,7]. Surveys repeatedly confirm that the longer the hypertension the higher the prevalence and severity of these echocardiographic impairments which motivate the idea of early treatment and strict blood pressure control in order to reduce cardiovascular risk in the long-term[7].

The echocardiograph-ographic evaluation of hypertensive people is an additional source of prognostic data and therapeutic choice. The presence of LVH or impaired diastolic could trigger more stringent blood pressure lowering and the choice of antihypertensive agents which have been shown to be beneficial on cardiac remodeling. In addition, when evaluating left atrial volume and reserve there are implications as to the risk of atrial fibrillation and stroke. It is recommended that periodic echocardiographic monitoring, especially in patients with chronic hypertension, are used to track the further development of the disease and the effectiveness of treatment[1,2,5].

To conclude, as part of overall assessment of hypertensive heart disease, echocardiography becomes central in providing the understanding of both the structural and functional outcomes of long-term hypertension. Its sensitivity to identify subclinical target organ damage enables it to stratify risks and conduct individualized management on time hence resulting in better cardiovascular outcomes.

## **MATERIAL AND METHODS**

### **Study Design:**

It will be a cross-sectional low that will be helpful in measuring the value of echocardiography in the assessment of hypertensive heart disease and association between hypertensive heart disease and period of hypertension. The research cuts across the Sri Aurobindo Medical College and Post Graduate Institute (SAIMS), Indore in Madhya Pradesh.

### **Study Population:**

Inpatients and outpatients that will be studied will be diagnosed with hypertension and will be aged above 18 years and undergo echocardiography at our hospital.

### **Data source:**

The information will be sourced form hypertensive patients of the Emergency Department of the institution (ED, SAIMS, Indore), and Outpatient Department of the institution (OPD, SAIMS, Indore), during the study period. The eligible patients who have written informed consent will be recruited in the study.

### **Inclusion Criteria:**

1. Patients with an age of above 18 years.
2. Patients hypertensives who/is known to develop hypertension over a period that may either be less than or more than 10 years.
3. Patients under medical examination that require echocardiography.

### **Exclusion Criteria:**

1. Patients with structural heart illnesses (e.g., congenital heart illnesses, severe maladies of valves).
2. Patients with a diagnosis of heart failure.
3. Those patients who fail to give written consent concerning the informed consent.

**Sample Size:**

Depending on the inclusion and exclusion criteria, the research will cover 132 hypertensive patients. This sample size is deemed to be appropriate because the SAIMS hospital attends to a number of about 132 newly diagnosed and already existing patients with hypertension annually.

**Methodology:**

After gaining a written informed consent of the patient, the included patients according to the inclusion criteria will be enrolled. To every patient, the following procedures will be done:

**1. Clinical Assessment:**

Each patient will have his/her medical history taken as detailed as possible, the history of hypertension, lifestyles, and comorbidity and family history of cardiovascular diseases will be included.

**2. Clinical Examination:**

Each patient will be provided with the full clinical assessment, which consists of detecting blood pressure (systolic and diastolic), the heart rate, and the body mass index (BMI).

**3. Investigations:****The following studies will be made on patients:**

- Complete Blood Count (CBC): To evaluate the general condition and identify the presence of anemia or infection.
- Liver Function Tests (LFT) and Renal Function Tests (RFT): Patients who have long-term high blood pressure may experience this impairment in liver and kidney performance; so, to assess them, LFT and RFT are detected.
- 2D Echocardiography: To determine the structural and functional values of the heart such as the value of the left ventricle, ejection fraction, diameter of the left atria, as well as the right ventricular pressure.
- Electrocardiogram (ECG): In order to assess electrical activity of the heart and reveal any arrhythmias.
- Chest X-ray: To determine presence of cardiac enlargement or presence of structural abnormalities.
- Urine Routine and Microscopic Examination (R/M): To assess the kidney and reveal the possibility of proteinuria that can be a frequent side-effect of hypertension.
- Fundus Examination: To know the symptoms of hypertensive retinopathy.

**4. Grouping by years of Hypertension:**

The patients will be divided into 2 groups on the basis of duration of hypertension they had:

**Group 1: less than 10 years of hypertension.**

**Group 2 : Hypertension of over 10 years.**

**Data Collection:**

The proforma that will be used to collect data will be a pre-structured proforma and it will capture:  
Demographic information (Age, sex, etc.)

- Biographical and medical history and physical findings
- Biochemical tests Results
- Echocardiographic data, cardiac size and functional values
- The results of other studies (ECG, Chest X-ray, etc).

Data will be directly copied onto the proforma by transcription of the reports thus ensuring accuracy and consistency.

**Statistical Analysis:**

Data recorded will be analysed using descriptive statistics in order to summarise patient demographics, clinical and echocardiographic characteristics. To analyse them comparatively, and to make inference, the two groups (patients with fewer than 10 years and more than 10 years with hypertension) will be compared with the help of relevant inferential statistical tests like:

- Continuous data (e.g., age, blood pressure, echocardiographic parameters) use independent t-tests.
- The p-value < 0.05 would be taken into account as statistically significant. The statistical analysis will be done using SPSS program (version 25 or above).

Ethical Considerations:

The research will comply with ethics according to the declaration of Helsinki. All participants will be requested to give a written informed consent prior to data collection. The information about all the patients will be kept secret and will only be used to conduct research.

## RESULTS

**Table 1: Classification of Patients Based on Duration of Hypertension**

Hypertension Duration (years)	Number of Patients	Percentage (%)
< 10 years	66	50%
> 10 years	66	50%
<b>Total</b>	132	100%

The Table 1 shows the classification of the hypertensive patients according to their hypertensive duration. The representative sample of 132 patients are split into two:

- Group 1 has a duration of hypertension of less than 10 years 66 patients accounting to 50 percent of the total numbers.
- Group 2 is comprised of the patients with hypertension longer than 10 years (66 patients, as well as 50 per cent of the patients completely).

**Table 2: Demographic and Clinical Characteristics of Patients (Categorized by Duration of Hypertension)**

Characteristic	< 10 Years (N = 66)	> 10 Years (N = 66)
Mean Age (years)	52.3 ± 7.6	66.1 ± 8.3
Male	35 (53%)	39 (59%)
Female	31 (47%)	27 (41%)
Mean BMI (kg/m <sup>2</sup> )	27.1 ± 3.2	28.2 ± 3.5
Comorbidities		
- Diabetes	8 (12%)	18 (27%)
- Hypertension	12 (18%)	8 (12%)
- Hyperlipidemia	3 (4%)	10 (15%)
- CKD	1 (1%)	3 (5%)
- None	42 (64%)	27 (41%)

Table 2 presents a summary of the demographic and clinical analysis of patients who had high blood pressure classified into two groups; one was formed by patients with a short duration and the other consisted of patients with a long history of the disease. The statistics are disaggregated in the following way:

- The mean age of patients under hypertension, aged less than 10 years (Group 1) is 52.3 ± 7.6 years and 53 percent are males and 47 percent are females. The average BMI is 27.1 with standard deviation 3.2 kg/m<sup>2</sup>. This group has fewer comorbidities with 12% of them having diabetes, 18% having hypertension, 4% having hyperlipidemia, 1% having chronic kidney disease (CKD), and 64% not having any significant comorbidities.

- In patients with a history of hypertension more than 10 years old (Group 2), the mean age becomes higher (66.1 ± 8.3 years), 59 percent of them are males, and 41 percent are females. The average BMI is a bit higher and stands at 28.2 ± 3.5 kg/m<sup>2</sup>. This group has a remarkable level of comorbidities, whereby, 27 percent have diabetes, 12 percent have hypertension, 15 percent have hyperlipidemia, and 5 percent have CKD. Cases wherein there were no other notable morbidities were experienced by only 41 percent of patients in the group.

**Table 3: Comparison of Echocardiographic Parameters (Group 1: <10 Years vs. Group 2: >10 Years)**

Echocardiographic Parameter	< 10 Years (Mean ± SD)	> 10 Years (Mean ± SD)	p-value
Left Ventricular End-Diastolic Diameter (LVEDD) (mm)	47.2 ± 4.3	51.1 ± 5.2	0.0001
Left Ventricular End-Systolic Diameter (LVESD) (mm)	30.4 ± 3.1	34.2 ± 3.8	0.001
Left Ventricular Ejection Fraction (LVEF) (%)	64.1 ± 5.8	58.7 ± 6.1	0.002
Right Ventricular Systolic Pressure (RVSP) (mmHg)	26.8 ± 5.5	29.4 ± 4.9	0.03

Aortic Root Diameter (mm)	27.5 ± 3.1	29.0 ± 2.8	0.05
Mitral Valve E-wave Velocity (cm/s)	83.2 ± 9.4	75.3 ± 8.1	0.001

Table-3 compares the important parameters of echocardiography between two set of hypertensive patients, namely one with less than 10-year history (Group 1) and the other with more than 10-year history (Group 2). The differences are significant between the following parameters:

Left Ventricular End-Diastolic Diameter (LVEDD): Patients who have more than 10 years of hypertension (51.1 ± 5.2 mm) have larger Left Ventricular End-Diastolic Diameter than the patients with less than 10 years (47.2 ± 4.3 mm) ( $p = 0.0001$ ). Similarly, left Ventricular End-Systolic Diameter (LVESD) is increased in the >10 years group (34.2 ± 3.8 mm) as opposed to those in the <10 years group (30.4 ± 3.1 mm) ( $p = 0.001$ ).

The Left Ventricular Ejection Fraction (LVEF) is more in < 10 years (64.1 ± 5.8%) patients compared to the > 10 years (58.7 ± 6.1) patients ( $p=0.002$ ) showing that during early years there is impairment of ventricular function with prolonged grief of hypertension.

The Right Ventricular Systolic Pressure (RVSP) also increases in the group with a greater than 10 years old (29.4 ± 4.9 mmHg) than the less than 10 years old (26.8 ± 5.5 mmHg) ( $p = 0.03$ ).

The Aortic Root Diameter differs greatly between the >10 years and the <10 years shows (29.0 ± 2.8 mm) and (27.5 ± 3.1 mm) respectively ( $p = 0.05$ ).

Lastly, the Mitral Valve E-wave Velocity is found to be lower in >10 years group (75.3 ± 8.1 cm/s) compared to that of <10 years group (83.2 ± 9.4 cm/s) as measured ( $p = 0.001$ ).

**Table 4: Prevalence of Structural Heart Diseases in Hypertensive Patients**

Structural Heart Disease	< 10 Years (%)	> 10 Years (%)	Total (%)
Left Ventricular Hypertrophy (LVH)	35%	60%	47.7%
Aortic Stenosis	10%	15%	12.5%
Mitral Regurgitation	8%	18%	13.6%
Congestive Heart Failure (CHF)	5%	12%	8.3%
Dilated Cardiomyopathy (DCM)	2%	5%	3.8%

Table 4 indicates the frequency of structural heart diseases among hypertensive patients determined by the duration of the hypertension. The following is depicted in the data:

Left Ventricular Hypertrophy (LVH) is much more common in patients who have had hypertension over 10 years (60%) than under 10 years (35%), which is in support of the fact that long term hypertension also has left ventricular effects. Prevalence of Aortic Stenosis is a little bit higher in the >10 years-old group (15%) as compared to the less than 10 years old group (10%).

• Mitral Regurgitation also occurs with a greater frequency in patients with a longer history of hypertension (18 percent vs. 8 percent).

One can find Congestive Heart Failure (CHF) in 12 percent of all patients who have more than 10 years of hypertension and just 5 percent in patients who have less than 10 years.

Dilated Cardiomyopathy (DCM) is uncommon although prevalent in the >10 years group (5%) rather than in the <10 years group (2%).

**Table 5: Comparison of Systolic and Diastolic Blood Pressure Between Groups**

Blood Pressure Parameter	< 10 Years (Mean ± SD)	> 10 Years (Mean ± SD)	p-value
Systolic BP (mmHg)	145.2 ± 12.4	155.3 ± 14.1	0.001
Diastolic BP (mmHg)	90.4 ± 8.6	95.2 ± 9.3	0.02

Table 5 presents results of comparison of blood pressure parameters identification within two groups. Important observations are:

• The SBP is considerably elevated in the patients having hypertension above 10 years (155.3 ± 14.1 mmHg) and below 10 years (145.2 ± 12.4 mmHg) ( $p = 0.001$ ).

- The Diastolic Blood Pressure (DBP) as well is higher among the >10 years (95.2 + - 9.3 mmHg) than in the <10 years (90.4+ -8.6 mmHg) (p = 0.02).

The suggested differences indicate that the longer the period of hypertension, the greater the rise in the both the systolic and the diastolic.

## DISCUSSION

The fact that there is a greater comorbid condition in having diabetes, dyslipidemia, and chronic kidney diseases in patients that have hypertension over 10 years is consistent with large epidemiological surveys. Hypertensive adults in the Korea National Health and Nutrition Examination Survey experienced a high level of obesity (60.1 percent), dyslipidemia (57.6 percent), and impaired fasting glucose (45.1 percent); importantly, 42.2 percent of all hypertensive adults had two or more comorbidities and 17.7 percent had three or more, and this proportion rose dramatically as they grew older[8]. This highlights the fact that the development of progressive multimorbidity is linked with prolonged hypertension.

Adverse cardiac remodeling seen by echocardiography in long-standing hypertension confirms earlier observations. Lee et al. showed that hypertensive patients have an augmented left ventricular mass, abnormal diastolic performance (tissue Doppler E/e increase), and left atrial enlargement parameters, which deteriorate with the time of the illness[8]. Chronic pressure overload on the other hand causes symmetric left-ventricular hypertrophy, which in turn develops into decline of systolic function, reported in reviews of hypertensive heart disease[9].

Longer duration of hypertension as a cause of quantitative alterations of left ventricular dimensions and function is associated with continuous remodeling. This was evident in Framingham Heart Study data that demonstrated increments of 50 g /m<sup>2</sup>, or more, in left ventricular mass indexed to height was associated with increment of cardiovascular events and mortality of 1.49-1.57 times over 4 years, demonstrating that structural enlargement spells doom[10]. In line with this, the results of increased LVEDD and LVESD and decreased LVEF in the >10-year group of the present study represent the sign of impaired early systolic functionality.

High right ventricular systolic pressure and dilated aortic roots in people with chronic hypertension also reflect the earlier published results of vascular remodeling and augmented afterload. Chronic hypertension that is characterized by sustained elevation of systolic and diastolic blood pressure is related to myocardial strain and arterial stiffness that lead to rise in pressures in the right side of the heart and aortic dilatation.

Lastly, the relative advance prevalence of the left ventricular hypertrophy, valvular regurgitations, aortic stenosis, and congestive heart failure in terms of the patients who had over a decade of hypertension confirms the progression of hypertensive heart disease. The structural sequelae highlights the need to have early and long-term blood pressure management to prevent remodeling and to maintain cardiac performance.

## CONCLUSION

This study demonstrates that the duration of hypertension significantly influences both the structural and functional aspects of the heart. Patients with hypertension lasting over 10 years show larger left ventricular dimensions, reduced ejection fraction, and higher right ventricular pressures, indicating progressive heart damage. Additionally, structural heart diseases such as Left Ventricular Hypertrophy, mitral regurgitation, and heart failure are more prevalent in long-term hypertensive patients. Blood pressure readings are higher in this group, along with a greater incidence of comorbidities. Early detection and management of hypertension are essential to prevent severe cardiovascular complications.

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