

ROLE OF TWO-DIMENSIONAL ECHOCARDIOGRAPHY IN THE EARLY DETECTION OF LEFT VENTRICULAR DIASTOLIC DYSFUNCTION AMONG PATIENTS WITH HYPERTENSION: A HOSPITAL-BASED CROSS-SECTIONAL STUDY.

Dr. Bajarang Lal Bansal^{1*}, Dr. Ashok Kumar², Dr. Chirag. C. Taunk³.

¹Professor & HOD, Department of Internal Medicine, Abhishek I Mishra Memorial Medical College and Hospital, Bhilai, Durg, Chhattisgarh, India.

²Associate Professor, Department of General Medicine, Abhishek I Mishra Memorial Medical College and Hospital, Bhilai, Durg, Chhattisgarh, India.

³Senior Resident, Department of Respiratory Medicine, Shri Shankaracharya Institute of Medical Sciences, Bhilai, Durg, Chhattisgarh, India.



Correspondence:

Dr. Bajarang Lal Bansal.

Professor & HOD, Department of Internal Medicine, Abhishek I Mishra Memorial Medical College and Hospital, Bhilai, Durg, Chhattisgarh, India.

Email:

blbansal2002@gmail.com

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Abstract

Background: Hypertension is a major risk factor for cardiovascular disease and causes progressive structural and functional changes in the myocardium. Left ventricular diastolic dysfunction (LVDD) is an early manifestation of hypertensive heart disease that often remains asymptomatic despite preserved systolic function. Early detection is essential to prevent progression to heart failure. Two-dimensional echocardiography is a reliable, non-invasive modality for identifying early diastolic dysfunction. **Objective:** To evaluate the role of two-dimensional echocardiography in the early detection of left ventricular diastolic dysfunction among patients with hypertension and to determine its association with selected clinical characteristics. **Methods:** This hospital-based cross-sectional study was conducted from December 2025 to May 2026 and included 120 adult patients with essential hypertension. All participants underwent clinical evaluation and two-dimensional echocardiography. Left ventricular systolic and diastolic functions were assessed using standard echocardiographic parameters including left ventricular ejection fraction, E/A ratio, E/e' ratio, deceleration time, isovolumetric relaxation time, left atrial volume index, and left ventricular mass index. Statistical analysis was performed using SPSS version 26.0. **Results:** Left ventricular diastolic dysfunction was detected in 58.3% of patients. Increasing age, longer duration of hypertension, uncontrolled blood pressure, and left ventricular hypertrophy were significantly associated with diastolic dysfunction. Grade I diastolic dysfunction was the most common finding. **Conclusion:** Two-dimensional echocardiography is an effective non-invasive tool for the early detection of left ventricular diastolic dysfunction in hypertensive patients. Routine echocardiographic evaluation may facilitate timely diagnosis, improve risk stratification, and support early intervention to reduce cardiovascular complications.

Keywords: Hypertension, Two-dimensional echocardiography, Left ventricular diastolic dysfunction, Tissue Doppler imaging, Left ventricular hypertrophy.



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INTRODUCTION

Hypertension is one of the most common cardiovascular disorders worldwide and a major contributor to morbidity and mortality. Persistent elevation of blood pressure leads to structural and functional changes in the heart, including left ventricular hypertrophy, myocardial fibrosis, and impaired ventricular relaxation. These alterations often occur before the appearance of clinical symptoms and increase the risk of heart failure, arrhythmias, stroke, and other cardiovascular complications.[1]

Left ventricular diastolic dysfunction (LVDD) is considered an early manifestation of hypertensive heart disease and may develop despite preserved left ventricular systolic function. Because patients are frequently asymptomatic during the initial stages, early identification of diastolic dysfunction provides an opportunity for timely intervention and better blood pressure management, thereby reducing the likelihood of progression to heart failure with preserved ejection fraction.[2,3]

Two-dimensional echocardiography, together with Doppler and tissue Doppler imaging, is a reliable, non-invasive method for evaluating cardiac structure and diastolic function. Echocardiographic parameters such as the E/A ratio, E/e' ratio,

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deceleration time, isovolumetric relaxation time, left atrial volume index, and left ventricular mass index are widely used for the assessment and grading of LVDD. Owing to its accuracy, availability, and cost-effectiveness, echocardiography has become an important investigation for the routine evaluation of hypertensive patients.[4]

Recent studies have demonstrated that advancing age, prolonged duration of hypertension, poor blood pressure control, and left ventricular hypertrophy are associated with a higher prevalence of left ventricular diastolic dysfunction and an increased risk of adverse cardiovascular outcomes.[5,6] Therefore, the present study was undertaken to evaluate the role of two-dimensional echocardiography in the early detection of left ventricular diastolic dysfunction among patients with hypertension and to determine its association with selected clinical characteristics.

Aim: To evaluate the role of two-dimensional echocardiography in the early detection of left ventricular diastolic dysfunction among patients with hypertension.

MATERIALS AND METHODS

This hospital-based cross-sectional observational study was conducted in the Departments of Medicine and Cardiology of a tertiary care teaching hospital from December 2025 to May 2026. A total of 120 adult patients (≥ 18 years) with previously diagnosed or newly detected essential hypertension attending the outpatient department or admitted to the medicine wards during the study period were enrolled after fulfilling the eligibility criteria.

Inclusion Criteria

- Patients aged 18 years or above.
- Patients with previously diagnosed or newly detected essential hypertension.
- Patients willing to undergo two-dimensional echocardiographic evaluation.
- Patients who provided written informed consent.

Exclusion Criteria

- Patients with known coronary artery disease or previous myocardial infarction.
- Patients with moderate or severe valvular heart disease.
- Patients with congenital heart disease or cardiomyopathy.
- Patients with persistent atrial fibrillation or other significant arrhythmias.
- Patients with severe chronic kidney disease or inadequate echocardiographic windows.

Study Procedure

All enrolled patients underwent detailed clinical evaluation, blood pressure measurement, and transthoracic two-dimensional echocardiography. Left ventricular systolic and diastolic functions were evaluated using standard echocardiographic parameters, including left ventricular ejection fraction, transmitral E/A ratio, E/e' ratio, deceleration time, isovolumetric relaxation time, left atrial volume index, and left ventricular mass index. Left ventricular diastolic dysfunction was graded according to contemporary echocardiographic recommendations.

Statistical Analysis

Statistical analysis was performed using SPSS version 26.0. Continuous variables were expressed as mean $\pm$ standard deviation, whereas categorical variables were presented as frequencies and percentages. Comparisons between groups were performed using the Independent Student's t-test for continuous variables and the Chi-square test or Fisher's exact test for categorical variables, as appropriate. A p-value of <0.05 was considered statistically significant.

RESULTS

A total of 120 hypertensive patients were included in the present study. Demographic characteristics, echocardiographic findings, and factors associated with left ventricular diastolic dysfunction were analysed. The findings are presented in the following tables and figures.

Table 1: Baseline demographic characteristics of the study participants (n=120)

Variable		Frequency	Percentage
Age (years)	18–40	20	16.7%
	41–50	30	25%
	51–60	42	35%
	>60	28	23.3%
Gender	Male	68	56.7%
	Female	52	43.3%

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The majority of participants belonged to the 51–60 years age group (35%). Male participants constituted 56.7% of the study population, indicating a slight male predominance.

Table 2: Echocardiographic findings among hypertensive patients (n=120)

Echocardiographic parameter	Frequency	Percentage
Preserved LVEF	111	92.5%
Left ventricular hypertrophy	67	55.8%
Increased LV mass index	62	51.7%
Left atrial enlargement	40	33.3%
Left ventricular diastolic dysfunction	70	58.3%

Preserved left ventricular ejection fraction was observed in 92.5% of patients. Left ventricular hypertrophy, increased left ventricular mass index, and left atrial enlargement were identified in 55.8%, 51.7%, and 33.3% of patients, respectively. Overall, left ventricular diastolic dysfunction was detected in 58.3% of hypertensive patients.

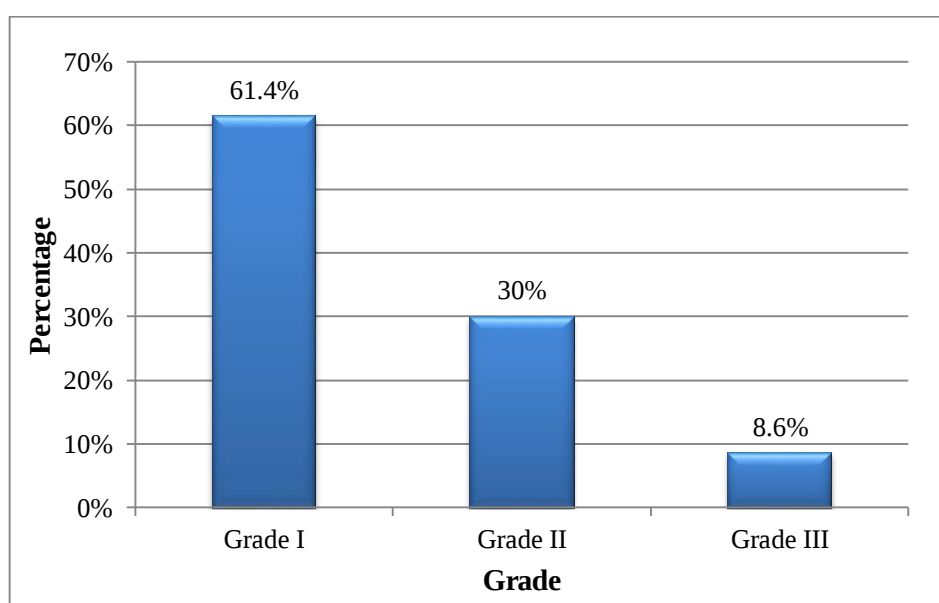


Figure 1: Distribution of Grades of Left Ventricular Diastolic Dysfunction Among Patients with LVDD (n=70)

Grade I diastolic dysfunction was the predominant finding (61.4%), followed by Grade II (30%) and Grade III (8.6%), indicating that impaired myocardial relaxation was the most common pattern of diastolic dysfunction.

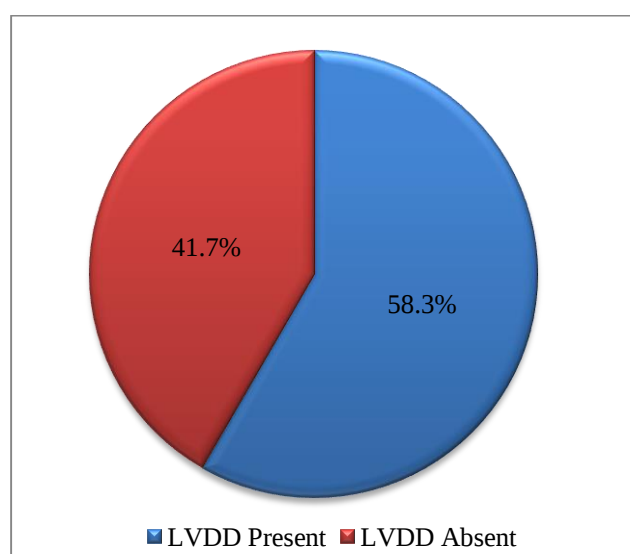


Figure 2: Prevalence of left ventricular diastolic dysfunction among hypertensive patients (n=120)

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Left ventricular diastolic dysfunction was present in 58.3% of hypertensive patients, whereas 41.7% had normal diastolic function.

Table 3: Association between duration of hypertension and left ventricular diastolic dysfunction

Duration of hypertension	LVDD Present	LVDD Absent	p-value
<5 years (n=44)	18	26	0.003
5–10 years (n=46)	29	17	
>10 years (n=30)	23	7	

The prevalence of left ventricular diastolic dysfunction increased significantly with increasing duration of hypertension ($p=0.003$), suggesting progressive impairment of diastolic function with prolonged disease duration.

Table 4: Association between blood pressure control and left ventricular diastolic dysfunction

Blood pressure status	LVDD Present	LVDD Absent	p-value
Controlled (n=46)	18	28	0.001
Uncontrolled (n=74)	52	22	

Left ventricular diastolic dysfunction was significantly more frequent among patients with uncontrolled hypertension than among those with controlled blood pressure ($p=0.001$), highlighting the importance of adequate blood pressure control.

DISCUSSION

The present hospital-based cross-sectional study evaluated the role of two-dimensional echocardiography in the early detection of left ventricular diastolic dysfunction (LVDD) among patients with hypertension. Left ventricular diastolic dysfunction was detected in 58.3% of the study participants despite preserved left ventricular systolic function in the majority of patients. These findings indicate that diastolic dysfunction is an early manifestation of hypertensive heart disease and may be identified before the development of overt systolic dysfunction. Similar observations have been reported in previous studies, supporting the value of echocardiography as a reliable, non-invasive modality for detecting subclinical myocardial dysfunction in hypertensive individuals.[7,8]

Grade I diastolic dysfunction was the predominant abnormality, accounting for 61.4% of patients with LVDD, suggesting that impaired myocardial relaxation represents the earliest stage of diastolic dysfunction in hypertension. The present study also demonstrated a significant association between longer duration of hypertension and the presence of LVDD. Furthermore, uncontrolled blood pressure was significantly associated with diastolic dysfunction, highlighting the adverse effects of persistent pressure overload on myocardial structure and function. These findings are in agreement with previous reports showing that prolonged hypertension and inadequate blood pressure control contribute to progressive impairment of left ventricular diastolic function and increase cardiovascular risk.[9,10]

More than half of the study participants had left ventricular hypertrophy, and increased left ventricular mass index was frequently associated with diastolic dysfunction. Chronic hypertension promotes myocardial hypertrophy, interstitial fibrosis, and reduced ventricular compliance, resulting in impaired ventricular relaxation. Although left ventricular ejection fraction remained preserved in most patients, evidence of diastolic dysfunction was already present, emphasizing that abnormalities of ventricular relaxation generally precede systolic impairment in hypertensive heart disease.[11,12]

Two-dimensional echocardiography, together with Doppler and tissue Doppler imaging, provides a comprehensive and non-invasive assessment of left ventricular diastolic function. Echocardiographic parameters such as the E/A ratio, E/e' ratio, left atrial volume index, and left ventricular mass index facilitate early detection of myocardial dysfunction and help identify patients at increased cardiovascular risk. The findings of the present study further support the routine use of two-dimensional echocardiography in hypertensive patients for early diagnosis, risk stratification, and timely therapeutic intervention, thereby reducing the likelihood of progression to symptomatic heart failure and other adverse cardiovascular outcomes.[2,13].

CONCLUSION

Left ventricular diastolic dysfunction is a common subclinical cardiac abnormality among patients with hypertension and frequently develops despite preserved left ventricular systolic function. The present study demonstrated a significant association of diastolic dysfunction with increasing age, longer duration of hypertension, uncontrolled blood pressure, and left ventricular hypertrophy. Two-dimensional echocardiography proved to be an effective, non-invasive, and reliable modality for the early detection of these functional abnormalities. Incorporating routine echocardiographic assessment into the evaluation of hypertensive patients may facilitate early diagnosis, improve cardiovascular risk stratification, and enable

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timely therapeutic interventions to prevent progression to symptomatic heart failure and other adverse cardiovascular outcomes.

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