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ECHOCARDIOGRAPHIC ASSESSMENT OF LEFT VENTRICULAR EJECTION FRACTION IN HYPERTENSIVE AND DIABETIC PATIENTS WITH LEFT VENTRICULAR HYPERTROPHY

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Abstract

Background: Hypertension and type 2 diabetes mellitus are major risk factors for cardiovascular disease and frequently lead to left ventricular hypertrophy (LVH). Persistent pressure overload and metabolic abnormalities may impair left ventricular systolic function, making assessment of left ventricular ejection fraction (LVEF) essential for early detection of cardiac dysfunction. Echocardiography is the preferred non-invasive modality for evaluating LVEF and LVH in these patients. **Objective**: To assess left ventricular ejection fraction using echocardiography in hypertensive and diabetic patients with left ventricular hypertrophy and determine its association with demographic and clinical characteristics. **Methods**: A retrospective cross-sectional analytical study was conducted at Rehman Medical Institute (RMI), Peshawar, over a period of six months. A total of 90 adult patients with hypertension, type 2 diabetes mellitus, and echocardiographically

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confirmed LVH were included using consecutive sampling. Demographic and clinical data were obtained from hospital records. Transthoracic echocardiography was used to evaluate LVEF and classify LVH. Data were analyzed using SPSS version 26. Continuous variables were expressed as mean ± standard deviation, while categorical variables were presented as frequencies and percentages. Chi-square test, independent t-test, and ANOVA were used where appropriate, with a p-value <0.05 considered statistically significant. **Results**: The mean age of participants was 59.01 ± 14.12 years, and 51.1% were male. Hypertension was present in 85.6% of patients, while 91.1% had diabetes mellitus. Concentric hypertrophy was the most common LVH pattern (45.6%), followed by eccentric hypertrophy (30.0%) and concentric remodeling (24.4%). Mildly impaired LVEF was the most frequent finding (31.1%). A statistically significant association was observed between hypertension and LVEF (χ^2 = 14.145, p = 0.003). However, no significant associations were found between LVEF and diabetes mellitus (p = 0.614), LVH type (p = 0.550), gender (p = 0.085), or age (p = 0.194). **Conclusion**: Hypertension was significantly associated with reduced left ventricular ejection fraction in patients with left ventricular hypertrophy, whereas diabetes mellitus, age, gender, and LVH geometry showed no significant association. Routine echocardiographic assessment of LVEF in hypertensive patients with LVH may facilitate early detection of systolic dysfunction and improve clinical management.

Keywords: Left ventricular ejection fraction, echocardiography, hypertension, diabetes mellitus, left ventricular hypertrophy, systolic function

Introduction

Hypertension and diabetes mellitus are among the leading non-communicable diseases worldwide and are major contributors to cardiovascular morbidity and mortality. Both conditions independently promote structural and functional alterations in the myocardium, predisposing patients to left ventricular hypertrophy (LVH), heart failure, ischemic heart disease, and premature death (Virani et al., 2021; Williams et al., 2018). The coexistence of hypertension and diabetes substantially increases cardiovascular risk due to their synergistic effects on myocardial remodeling and ventricular dysfunction (Cosentino et al., 2020).

Left ventricular hypertrophy is a compensatory response to chronic pressure overload in hypertension and metabolic abnormalities associated with diabetes mellitus. Persistent elevation of blood pressure results in increased left ventricular wall stress, stimulating myocardial hypertrophy and fibrosis. Similarly, diabetes contributes to myocardial remodeling through hyperglycemia-induced oxidative stress, inflammation, microvascular dysfunction, and extracellular matrix deposition, leading to diabetic

cardiomyopathy (Jia et al., 2018). Although initially adaptive, LVH eventually impairs myocardial relaxation and contractility, increasing the risk of heart failure, arrhythmias, and sudden cardiac death (Levy et al., 1990).

Left ventricular ejection fraction (LVEF) is the most widely used echocardiographic parameter for assessing global systolic function. It represents the percentage of blood ejected from the left ventricle during systole and serves as an important prognostic indicator in patients with cardiovascular disease. While patients with hypertension or diabetes may maintain a preserved LVEF during the early stages of myocardial remodeling, progressive hypertrophy and fibrosis can ultimately result in systolic dysfunction and reduced ejection fraction (Lang et al., 2015). Therefore, assessment of LVEF remains essential for identifying subclinical cardiac dysfunction and guiding therapeutic interventions.

Echocardiography is the imaging modality of choice for evaluating left ventricular structure and function because of its non-invasive nature, wide availability, and high diagnostic accuracy. It enables accurate measurement of ventricular wall thickness, chamber dimensions, left ventricular mass, and ejection fraction, facilitating early detection of hypertensive heart disease and diabetic cardiomyopathy (Lang et al., 2015). Early recognition of impaired ventricular function allows timely implementation of pharmacological and lifestyle interventions that may slow disease progression and reduce cardiovascular complications.

Several studies have demonstrated that patients with both hypertension and diabetes exhibit greater left ventricular remodeling and poorer systolic function compared with individuals having either condition alone (Bohm et al., 2017; Jia et al., 2018). However, the degree to which left ventricular ejection fraction is affected in hypertensive and diabetic patients with established LVH varies among populations and remains insufficiently investigated in many tertiary care settings.

Therefore, the present study aims to evaluate left ventricular ejection fraction by echocardiography in hypertensive and diabetic patients with left ventricular hypertrophy. The findings may contribute to early identification of systolic dysfunction and improve risk stratification and management of high-risk cardiovascular patients.

Materials and Methods

This retrospective cross-sectional analytical study was conducted at **Rehman Medical Institute (RMI), Peshawar**, a tertiary care hospital with a dedicated echocardiography laboratory, over a period of **six months**. A final sample of **90 patients** was included, calculated using the **Raosoft online sample size calculator** (95% confidence level, 5% margin of error, population size = 100), with an additional 10–15% added to

compensate for incomplete records. **Consecutive sampling** was used to recruit eligible participants.

The study included adults (>18 years) with hypertension, type 2 diabetes mellitus, echocardiographically confirmed left ventricular hypertrophy (LVH), and those undergoing transthoracic echocardiography for assessment of left ventricular ejection fraction (LVEF). Patients with ischemic heart disease, previous myocardial infarction, significant valvular heart disease, congenital heart disease, or non-hypertensive cardiomyopathies were excluded.

Clinical and demographic data were collected from hospital records using a structured data collection form. Transthoracic echocardiography was performed by trained personnel to evaluate left ventricular hypertrophy and measure left ventricular ejection fraction. Data were analyzed using **SPSS version 26.0**. Continuous variables were expressed as **mean ± standard deviation**, while categorical variables were presented as **frequencies and percentages**. Comparisons were performed using the **independent t-test or ANOVA** for continuous variables and the **chi-square test** for categorical variables. A **p-value < 0.05** was considered statistically significant.

Results

This chapter presents the findings of the retrospective cross-sectional study conducted among **90 patients** with hypertension, diabetes mellitus, and echocardiographically confirmed left ventricular hypertrophy (LVH). The objective of the study was to evaluate left ventricular ejection fraction (LVEF) and determine its association with demographic characteristics and clinical variables, including hypertension, diabetes mellitus, age, gender, and LVH type. The results are presented using descriptive statistics, frequency distributions, cross-tabulations, and inferential statistical tests.

Table 1. *Demographic Characteristics of Study Participants*

Variable	Value
Sample size (N)	90
Mean age (years)	59.01 ± 14.12
Age range (years)	31–81

Interpretation

The mean age of the participants was **59.01 ± 14.12 years**, with ages ranging from **31 to 81 years**.

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Table 2. *Clinical Characteristics of Study Participants*

Variable	Frequency	Percentage (%)
Gender		
Male	46	51.1
Female	44	48.9
Hypertension		
Yes	77	85.6
No	13	14.4
Diabetes Mellitus		
Yes	82	91.1
No	8	8.9
Type of LVH		
Concentric hypertrophy	41	45.6
Eccentric hypertrophy	27	30.0
Concentric remodeling	22	24.4

Interpretation

Among the 90 participants, **51.1% were male** and **48.9% were female**. Hypertension was present in **85.6%**, while **91.1%** had diabetes mellitus. The most common LVH pattern was **concentric hypertrophy (45.6%)**, followed by eccentric hypertrophy (30.0%) and concentric remodeling (24.4%).

Table 3. *Distribution of Left Ventricular Ejection Fraction (LVEF)*

LVEF Category	Frequency	Percentage (%)
Preserved	24	26.7
Mild impaired	28	31.1
Moderate impaired	22	24.4
Severe impaired	16	17.8
Total	**90**	**100**

Interpretation

Mildly impaired LVEF was the most common finding (**31.1%**), followed by preserved LVEF (**26.7%**), moderate impairment (**24.4%**), and severe impairment (**17.8%**).

Table 4. *Association Between Hypertension and Left Ventricular Ejection Fraction*

Hypertension	Preserved	Mild	Moderate	Severe	Total
Yes	15	26	21	15	77
No	9	2	1	1	13

Chi-square Test			
Test	**χ^2**	**df**	**p-value**
Pearson Chi-square	14.145	3	**0.003**

Interpretation

There was a **statistically significant association** between hypertension and LVEF (**χ^2 = 14.145, p = 0.003**). Most hypertensive patients were distributed among the impaired LVEF categories, indicating poorer systolic function.

Table 5. ***Association Between Diabetes Mellitus and Left Ventricular Ejection Fraction***

Diabetes Mellitus	Preserved	Mild	Moderate	Severe	Total
Yes	23	24	20	15	82
No	1	4	2	1	8

Chi-square Test			
Test	**χ^2**	**df**	**p-value**
Pearson Chi-square	1.806	3	0.614

Interpretation

Although most diabetic patients had impaired LVEF, **no statistically significant association** was observed between diabetes mellitus and LVEF (**p = 0.614**).

Table 6. Association Between LVH Type and Left Ventricular Ejection Fraction

LVH Type	Preserved	Mild	Moderate	Severe	Total
Concentric hypertrophy	13	13	11	4	41
Eccentric hypertrophy	5	10	6	6	27
Concentric remodeling	6	5	5	6	22

Chi-square Test			
Test	**χ^2**	**df**	**p-value**
Pearson Chi-square	4.949	6	0.550

Interpretation

No statistically significant association was found between LVH type and LVEF (**χ^2 = 4.949, p = 0.550**).

Table 7. ***Association Between Gender and Left Ventricular Ejection Fraction***

Gender	Preserved	Mild	Moderate	Severe	Total
Male	8	19	12	7	46
Female	16	9	10	9	44

Chi-square Test

Test	χ^2	df	p-value
Pearson Chi-square	6.629	3	0.085

Interpretation

No statistically significant association was found between gender and LVEF (**p = 0.085**).

Table 8. *Comparison of Age Across LVEF Categories (ANOVA)*

Variable	F-value	p-value
Age	1.604	0.194

Interpretation

The mean age did not differ significantly across LVEF categories (**F = 1.604, p = 0.194**).

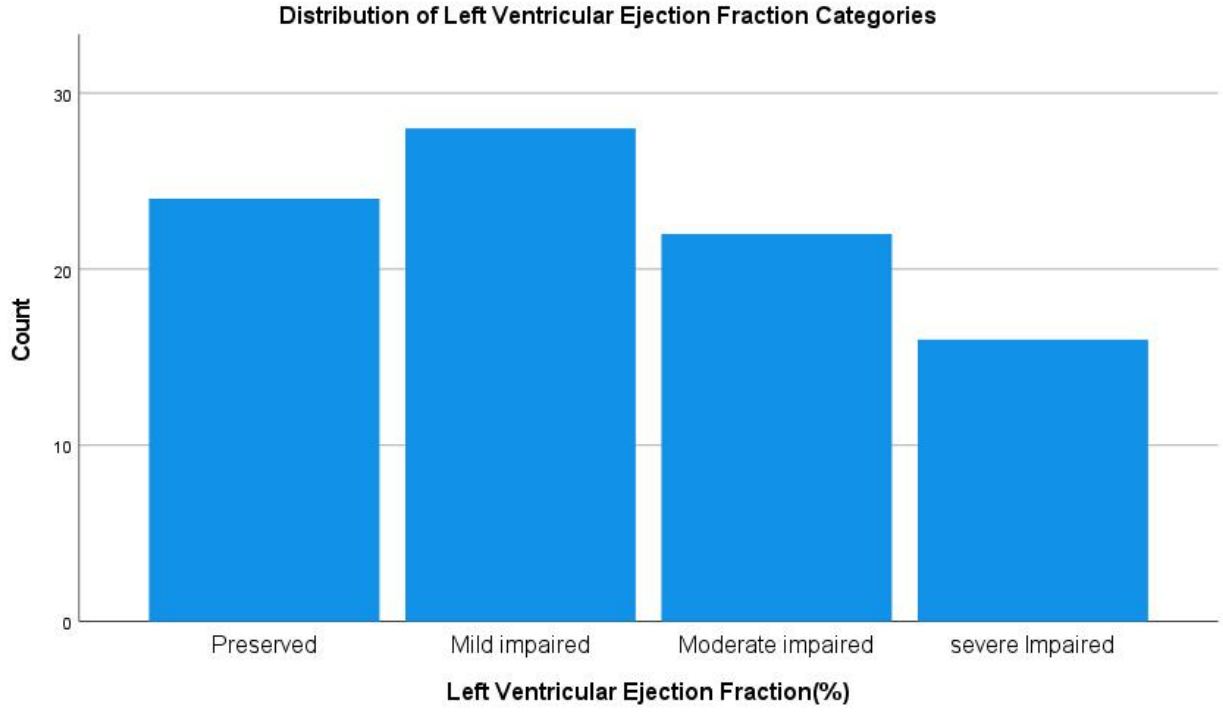

Figure 1. Distribution of Left Ventricular Ejection Fraction Categories

The majority of patients had **mildly impaired LVEF**, followed by preserved, moderately impaired, and severely impaired LVEF.

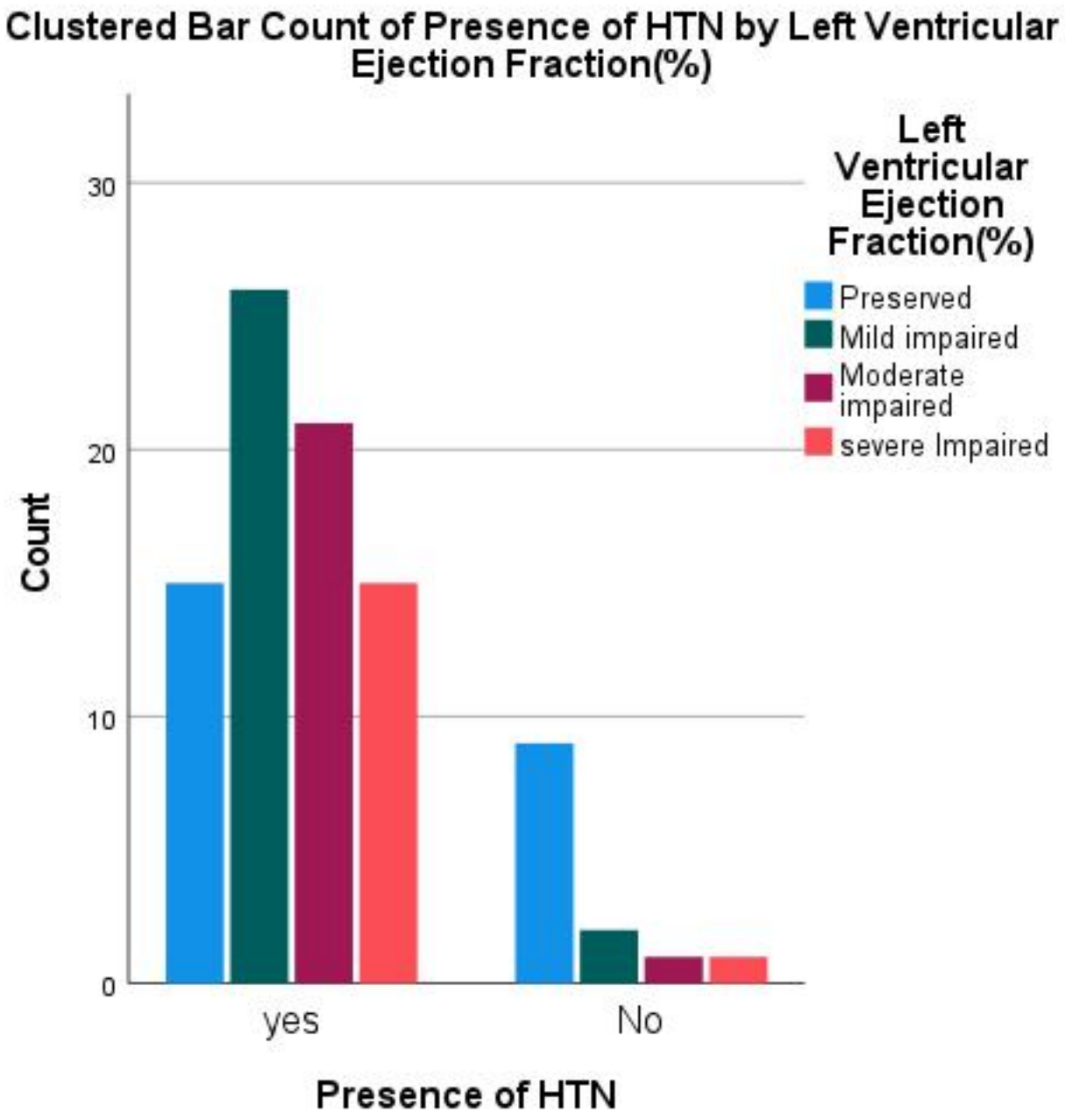

Figure 2. Association Between Hypertension and Left Ventricular Ejection Fraction

Hypertensive patients were predominantly distributed among the impaired LVEF categories, demonstrating a statistically significant association between hypertension and reduced LVEF.

Among the 90 study participants, the mean age was **59.01 ± 14.12 years**, and males comprised **51.1%** of the study population. Most participants had hypertension (**85.6%**) and diabetes mellitus (**91.1%**), while concentric hypertrophy was the most frequent LVH pattern (**45.6%**). Mildly impaired LVEF was the most common echocardiographic finding (31.1%).

Hypertension showed a **significant association** with left ventricular ejection fraction (**χ^2 = 14.145, p = 0.003**), indicating that hypertensive patients were more likely to have impaired systolic function. In contrast, diabetes mellitus (**p = 0.614**), LVH type (**p = 0.550**), gender (**p = 0.085**), and age (**p = 0.194**) were **not significantly associated** with LVEF. These findings suggest that hypertension was the principal clinical factor associated with reduced left ventricular systolic function in this study population.

Discussion

This study aimed to assess left ventricular ejection fraction echocardiographically in hypertensive and diabetic patients with left ventricular hypertrophy. A total of 90 patients were enrolled, with a mean age of 59.01 ± 14.119 years. The study population was nearly equally distributed between males (51.1%) and females (48.9%), reflecting a balanced gender representation. The majority of patients had hypertension (85.6%) and diabetes mellitus (91.1%), which is consistent with the well-established co-existence of these two conditions in clinical practice. Concentric LVH was the most prevalent pattern identified (45.6%), followed by eccentric LVH (30.0%) and concentric remodeling (24.4%), which aligns with previous studies reporting concentric hypertrophy as the dominant geometric pattern in hypertensive patients.

With regard to left ventricular ejection fraction, hypertension demonstrated a statistically significant association with LVEF (χ^2 = 14.145, p = 0.003). The majority of hypertensive patients were distributed across the impaired LVEF categories, indicating that hypertension contributes meaningfully to systolic left ventricular dysfunction. This finding is in agreement with existing literature, which consistently identifies hypertension as a major risk factor for the development of left ventricular systolic impairment. Chronic pressure overload from sustained hypertension leads to myocardial remodeling, which over time impairs contractile function and reduces ejection fraction.

In contrast, diabetes mellitus did not show a statistically significant association with LVEF in this study (χ^2 = 1.806, p = 0.614). Although diabetes is widely recognized as a risk factor for cardiomyopathy and left ventricular dysfunction, the lack of significance in this study may be attributed to the high prevalence of diabetes across the study population (91.1%), which limits the ability to detect meaningful differences between

diabetic and non-diabetic subgroups due to the very small size of the non-diabetic group. This finding should therefore be interpreted with caution.

Gender did not show a statistically significant association with LVEF ($\chi^2 = 6.629$, $p = 0.085$), although a trend was noted, with males more frequently presenting with mild impairment and females more frequently presenting with preserved ejection fraction. This trend is consistent with previously reported sex differences in cardiac remodeling, where females tend to maintain systolic function longer than males in the setting of hypertension. Similarly, LVH type did not demonstrate a statistically significant association with LVEF ($\chi^2 = 4.949$, $p = 0.550$), and no significant difference in mean age across LVEF categories was observed ($F = 1.604$, $p = 0.194$), suggesting that neither LVH geometry nor age independently determined the degree of systolic dysfunction in this cohort.

Conclusion

This study assessed left ventricular ejection fraction echocardiographically in 90 hypertensive and diabetic patients with left ventricular hypertrophy. The findings demonstrate that hypertension is significantly associated with impaired left ventricular ejection fraction, highlighting its central role in the development of systolic dysfunction in this patient population. Diabetes mellitus, gender, age, and LVH type did not show statistically significant associations with LVEF, although the high prevalence of diabetes in the study sample limits the interpretation of this finding. Concentric LVH was the most common geometric pattern identified, which is consistent with the hemodynamic burden imposed by chronic hypertension. Echocardiography proved to be a valuable tool in detecting and categorizing left ventricular dysfunction in this population. Early echocardiographic assessment in hypertensive and diabetic patients with LVH is recommended to identify systolic impairment at an early stage and guide timely clinical management. Future studies with larger and more balanced sample sizes are recommended to further evaluate the independent contributions of diabetes mellitus and LVH geometry to left ventricular dysfunction.

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