

ORIGINAL ARTICLE

ASSESSMENT OF LEFT VENTRICULAR HYPERTROPHY INCIDENCE AND ANTIHYPERTENSIVE THERAPY EFFICACY IN HYPERTENSIVE PATIENTS**Samia Perwaiz Khan¹, Harris Majeed¹, Safia Izhar¹, Shaista Kanwal¹, Raaeqah Ahmed¹, Rimsha Munawar¹, Somal Meraj¹, Laiba Naz¹**¹JMDC, Sohail University, Karachi, Pakistan

Objectives: This study aimed to assess the incidence of left ventricular hypertrophy (LVH) in hypertensive individuals in Karachi, Pakistan, and to evaluate the effectiveness of antihypertensive therapy in preventing LVH.

Methodology: A total of 200 hypertensive patients were referred from the Cardiac OPD to the Radiology department of Medicare Cardiac and General Hospital, Karachi, for echocardiography. Echocardiographic measurements of cardiac chambers were performed by expert echocardiographers, and left ventricular mass (LVM) was calculated using the formula recommended by the American Society of Echocardiography.

Results: Among the hypertensive patients, 100 had uncontrolled blood pressure ($\geq 140/90$ mmHg) while 100 had controlled blood pressure ($\leq 130/80$ mmHg). The female-to-male ratio was 3:1, with ages ranging from 21 to 80 years. Patients with uncontrolled hypertension exhibited a higher mean body mass index (29 ± 5 kg/m²) and significantly elevated LVM (mean 154 ± 4 g/m²). Angiotensin receptor inhibitors were the most commonly prescribed and effective antihypertensive agents, either as monotherapy or in combination therapy (60%), demonstrating utility in preventing LVH.

Conclusion: This study highlights a high incidence of LVH in uncontrolled hypertensive individuals compared to those with controlled hypertension. Transthoracic echocardiography emerged as a highly valuable, non-invasive tool for measuring LVM and assessing the effectiveness of antihypertensive therapy.

Keywords: Left ventricular hypertrophy, echocardiography, left ventricular mass, relative wall thickness, ACE inhibitors

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INTRODUCTION

Transthoracic echocardiography represents a cornerstone in cardiac assessment due to its non-invasiveness and accuracy in measuring cardiac chamber size and function.^{1,2} Particularly in hypertensive patients, where the risk of cardiovascular complications is heightened, echocardiography plays a crucial role in detecting abnormalities and guiding management decisions. Uncontrolled hypertension presents a significant health hazard, predisposing individuals to conditions such as congestive cardiac failure and chronic kidney failure.^{3,4} In this context, echocardiography emerges as an essential diagnostic tool, aiding in the identification of left ventricular

hypertrophy (LVH), a common manifestation of uncontrolled hypertension. LVH serves as a predictor of target organ damage and is associated with an increased risk of adverse cardiovascular events, including heart failure.^{5,6}

Despite advancements in antihypertensive therapy, challenges persist in effectively managing LVH in hypertensive patients.⁷⁻⁹ While regression of LVH through antihypertensive therapy is associated with a decreased risk of cardiovascular events, certain medications exhibit varying degrees of efficacy in reducing LVH.¹⁰ Renin-angiotensin-aldosterone system blockers have shown superior efficacy in regressing LVH compared to other classes of antihypertensive drugs such as calcium channel

blockers and beta-blockers.^{11,12} However, calcium channel blockers, although effective in blood pressure control, have demonstrated limited potency in reducing cardiac remodeling, potentially increasing the risk of heart failure in hypertensive patients.¹³ Monitoring blood pressure control through follow-up echocardiography is crucial in assessing treatment efficacy and guiding therapeutic interventions to prevent LVH progression.¹⁴

Against this backdrop, this study aims to investigate cardiac measurements via echocardiography and determine the prevalence of LVH among hypertensive individuals in the Pakistani population of Karachi. Furthermore, it seeks to evaluate the effectiveness of antihypertensive therapy in preventing an increase in left ventricular mass through longitudinal follow-ups. By elucidating the relationship between antihypertensive therapy, LVH regression, and cardiovascular outcomes, this study endeavors to contribute valuable insights to the optimization of management strategies for hypertensive patients. Ultimately, the findings of this study hold the potential to inform clinical practice and improve patient outcomes in the context of hypertension management.

METHODOLOGY

Study Design: This study employed an observational approach to investigate cardiac parameters in hypertensive Pakistani individuals. It focused on comparing echocardiographic measurements between two groups: those with controlled hypertension and those with uncontrolled hypertension.

Setting: The study was conducted at the OPD of Medicare Cardiac and General Hospital in Karachi, utilizing the institution's resources and patient pool from November 2022 to August 2023.

Participants: The study involved hypertensive individuals, comprising 100 with controlled hypertension and 100 with uncontrolled hypertension. Participants were selected from those visiting the hospital, reflecting a cross-section of the hypertensive population seeking medical care.

Variables: The main variables of interest included interventricular septum (IVS), left ventricular internal diameter (LVID), posterior wall thickness (PWT), and left ventricular mass (LVM). These variables were assessed through echocardiographic measurements using a GE-Vivid S60N Sonography machine.

Data Sources/Measurement: Data collection involved trans-thoracic echocardiography performed on hypertensive patients after obtaining informed

consent. Measurements were taken using M-mode echocardiography in the parasternal long axis view and parasternal short axis view, as well as 2-Dimension echocardiography.

Bias: Efforts were made to minimize bias by ensuring standardized procedures for data collection and measurement. Additionally, patient selection was randomized to reduce selection bias.

Study Size: A total of 200 hypertensive individuals were included in the study, with equal distribution between controlled and uncontrolled hypertension groups to allow for meaningful comparison.

Quantitative Variables: Quantitative variables such as blood pressure, BMI, and echocardiographic measurements were analyzed using descriptive statistics, expressed as mean \pm standard deviation or in percentages as appropriate.

Ethics: Ethical considerations were adhered to throughout the study, with informed consent obtained from all participants. The study protocol was reviewed and approved by the institutional ethics committee.

Statistical Methods: Data analysis was performed using SPSS 25.0 software. Descriptive statistics were utilized to summarize baseline characteristics and echocardiographic measurements. Student's t-test was applied to compare means between controlled and uncontrolled hypertensive groups. Additionally, outcomes of therapy in all treatment groups were presented in percentages to assess effectiveness.

RESULTS

Participants: The study comprised 200 hypertensive patients undergoing follow-up at the Cardiac OPD, with 100 individuals exhibiting uncontrolled blood pressure ($\geq 140/90$ mm Hg) and 100 individuals with controlled blood pressure ($< 130/80$ mm Hg). All patients were on various antihypertensive therapies, including ACE Inhibitors, ARBs, CCBs, BBs, or combinations thereof. The majority of patients with uncontrolled hypertension were female, with a female-to-male ratio of 3:1, and had a mean age of 60 ± 10 years. Notably, many of these patients were overweight or obese, with a mean BMI of 27 ± 10 kg/m².

Descriptive Data: Echocardiographic assessments were conducted on all participants, revealing significant differences between the uncontrolled and controlled hypertension groups. In the uncontrolled hypertension group, mean values for LVM, left ventricular mass index (LVMI), IVS, PWT, LVID, body surface area (BSA), and ejection fraction (EF%)

were notably higher compared to the controlled hypertension group. Specifically, LVM was substantially elevated in the uncontrolled hypertension group (mean 154 g) compared to the controlled group (mean 55 g), indicating a significant difference ($p < 0.001$). Other echocardiographic parameters such as IVS, PWT, LVID, and EF% also exhibited statistically significant differences between the two groups.

Outcome Data: Analysis of anti-hypertensive drug therapy outcomes revealed variations in medication usage between the two groups. ACE Inhibitors/ARBs were more frequently prescribed in the controlled hypertension group (60%) compared to the uncontrolled group (40%). Conversely, calcium channel blockers (CCBs) were more commonly used in the uncontrolled hypertension group (40%) compared to the controlled group (20%). Beta-blockers (BBs) and combination antihypertensive therapies were utilized to a lesser extent in both groups.

Main Results: The study reveals significant differences in echocardiographic parameters between hypertensive patients with controlled and uncontrolled blood pressure. Patients with uncontrolled hypertension exhibit higher LVM, LVMI, IVS, PWT, LVID, and lower EF % compared to those with controlled hypertension. Additionally, a higher prevalence of overweight and obesity is observed among patients with uncontrolled hypertension.

Prescription patterns also differ, with ACE Inhibitors/ARBs more commonly prescribed in controlled hypertension and calcium channel blockers (CCBs) in uncontrolled hypertension.

DISCUSSION

The study involved two hundred hypertensive patients undergoing antihypertensive therapy, who were recommended to undergo echocardiography conducted by highly trained echocardiographers. The patients, ranging in age from 21 to 80 years, exhibited a BMI range of 27 to 40 kg/m², with increased left ventricular mass (LVM) observed (mean of 154 ± 4 g). Notably, the female-to-male ratio was 3:1, with a significant portion of females falling within the menopausal age group above 60 years. A comparative study conducted on the Pakistani population reported a male proportion of 65% and a mean age of 60 years.¹⁵

Concentric left ventricular hypertrophy, characterized by an increase in left ventricular myocardial mass due to chronic pressure overload, was predominantly observed in the study participants, likely stemming from long-standing uncontrolled hypertension despite antihypertensive medication use. This condition, with LVM ranging from 77 to 249 g (mean of 154 g) in patients with uncontrolled hypertension, poses an elevated risk of congestive cardiac failure, stroke, and coronary vascular diseases.

Table 1: Clinical characteristics, Echocardiographic M-mode, findings, and anti-hypertensive drug therapy of participants with uncontrolled and control hypertensive patients

Variables	Hypertension		P-Value
	Uncontrolled BP ≥140/90 mmHg	Control BP ≤130/80 mmHg	
Total (N)	100	100	-
Mean Age (years)	60 ± 20	55 ± 20	0.500
Gender			
Female	73 (73.0%)	70 (70.0%)	0.100
Male	27 (27.0%)	30 (30.0%)	
Body Mass Index (kg/m²)			
Normal (18 - 23)	30 (30.0%)	40 (40.0%)	0.001
Overweight (23 - 29)	38 (38.0%)	10 (10.0%)	
Obese (29 or above)	32 (32.0%)	50 (50.0%)	
Mean Systolic BP (mmHg)	140 ± 20	130 ± 10	0.001
Mean Diastole BP (mmHg)	90 ± 11	80 ± 10	0.001
Echocardiography			
Interventricular septum (mm)	11 ± 5	5 ± 0.5	0.001
Posterior wall thickness (mm)	11 ± 3	6 ± 0.6	0.050
Left ventricular internal diameter (mm)	55 ± 5	40 ± 4	0.050
Left ventricular mass (gm)	154 ± 36	55 ± 20	0.001
Left ventricular mass index (g/m ²)	86 ± 20	69 ± 10	0.050
Ejection fraction (%)	40 ± 5	55 ± 5	0.001
Anti-Hypertensive Drugs			
ACE-Inhibitors/ARB	40 (40%)	60 (60%)	<0.001
Calcium channel blockers (CCB)	40 (40%)	20 (20%)	
Beta-blockers (BB)	10 (10%)	15 (15%)	
Combination anti-hypertensive therapy	10 (10%)	5 (5%)	

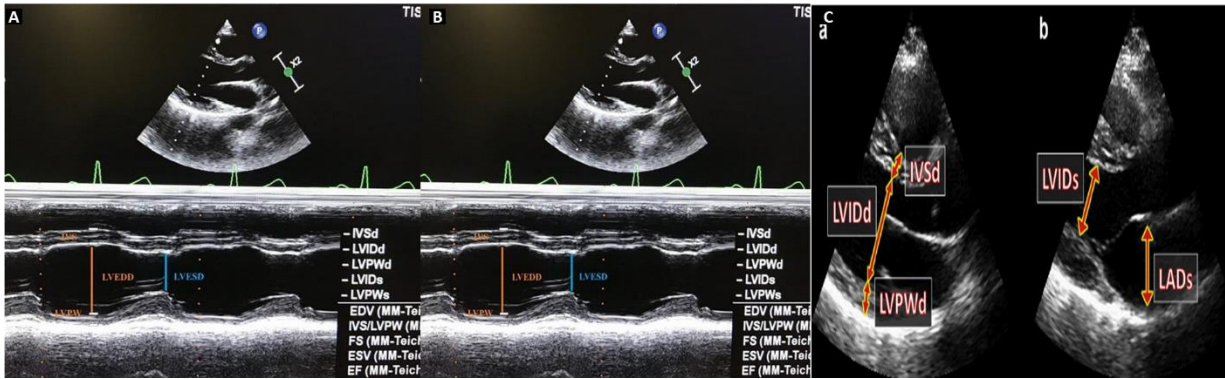


Figure 1: M-mode Echocardiography, 2D Cardiac Measurements (A), Echocardiography, measurement of Left Ventricular Mass (B), and Parasternal long axis view showing measurement of Left Ventricular Mass (C)

Elevated BMI emerged as a significant contributing risk factor for hypertension and left ventricular hypertrophy, aligning with findings from previous studies.¹⁶⁻²⁰

Effective blood pressure control stands as the cornerstone in preventing heart failure development, with ACE inhibitors, beta-blockers, calcium channel blockers, and combination antihypertensive therapies recognized for their efficacy in mitigating heart failure risk factors.^{21,22} Various antihypertensive medications, including ACE inhibitors, angiotensin receptor blockers, beta-blockers, calcium channel blockers, and aspirin as antiplatelet therapy, were prescribed to the study population. The incidence of left ventricular hypertrophy in our study population was 50%, consistent with reported incidences ranging from 36% to 41% in hypertensive individuals.²³⁻²⁵ While diuretics have shown utility in reducing left ventricular mass, their effectiveness in hypertrophy regression appears comparatively limited. Conversely, ACE inhibitors, either as monotherapy or in combination therapy, have demonstrated effectiveness in left ventricular mass regression.

LIMITATION

While echocardiography is widely regarded as a valuable tool, its accuracy may be influenced by factors such as operator expertise and equipment variability. Additionally, the study's focus on hypertensive patients receiving antihypertensive therapy may introduce selection bias, limiting the generalizability of the findings to broader hypertensive populations. Future research incorporating diverse diagnostic methods, larger sample sizes, and prospective study designs could provide a more comprehensive understanding of left ventricular hypertrophy in hypertensive populations.

CONCLUSION

Echocardiography emerges as a pivotal diagnostic tool for the early detection of left ventricular hypertrophy, a condition that, if left unmanaged, can lead to cardiac failure. Its utility lies in the ability to identify increases in left ventricular mass, providing crucial insights into cardiac health. Alongside antihypertensive therapy, lifestyle modifications play a crucial role in managing uncontrolled hypertension, especially in patients experiencing symptoms such as dyspnea and edema. Furthermore, the regression of left ventricular measures stands out as a highly desirable outcome of ACE inhibitor or ARB therapy, underscoring the importance of these medications in hypertension management.

AUTHORS' CONTRIBUTION

SPK and HM: Concept and design, data acquisition, interpretation, drafting, final approval, and agree to be accountable for all aspects of the work. SI, SK, RA, RM, SM, and LN: Data acquisition, interpretation, drafting, final approval and agree to be accountable for all aspects of the work.

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