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Echocardiographic Assessment of Cardiac Function in Coronary Artery Disease Patients over a 12-Week Treatment Period

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Abstract

Coronary artery disease (CAD) is a leading cause of global morbidity and mortality, with progressive left ventricular dysfunction being a critical determinant of prognosis. Serial monitoring of cardiac function during guideline-directed medical therapy (GDMT) is essential, yet data on the short-term echocardiographic trajectory in a real-world setting are limited. Objective: This study aimed to prospectively assess changes in echocardiographic parameters of cardiac function in CAD patients over a standardized 12-week GDMT period. This prospective cohort study was conducted at International Medical College, Dhaka, Bangladesh, from January to December 2023. Using purposive sampling, 63 diagnosed CAD patients were enrolled. All participants received optimized GDMT per standard protocols. Transthoracic echocardiography was performed at baseline and after 12 weeks, with key measurements including left ventricular ejection fraction (LVEF), end-diastolic volume (LVEDV), end-systolic volume (LVESV), and E/e' ratio. Data were analyzed using SPSS version 23.0, employing paired t-tests for normally distributed data ($p<0.05$ considered significant). Among 63 patients (mean age 58.7±9.2 years, 68.3% male), significant improvements were observed in key echocardiographic parameters after 12 weeks. Left ventricular ejection fraction increased from 45.2±7.8% to 49.5±8.1% ($p=0.003$). Concurrently, left ventricular end-systolic volume decreased from 68.5±15.2 mL to 62.1±14.7 mL ($p=0.010$), and the average E/e' ratio declined from 12.4±3.1 to 10.8±2.9 ($p=0.020$). A 12-week course of guideline-directed medical therapy in CAD patients leads to significant early echocardiographic improvement in systolic and diastolic function. These findings support the utility of short-interval echocardiographic follow-up to objectively monitor therapeutic response.

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Introduction

Coronary artery disease (CAD) remains the paramount contributor to global cardiovascular mortality and a leading cause of chronic heart failure, imposing a substantial socioeconomic burden worldwide.[1] The pathophysiological cornerstone of CAD involves atherosclerotic plaque accumulation within the coronary arteries, leading to myocardial ischemia or infarction. This process frequently precipitates left ventricular (LV) remodeling, a maladaptive cascade characterized by molecular, cellular, and interstitial changes that manifest as alterations in LV size, shape, and function.[2] The resultant LV systolic and diastolic dysfunction is a critical determinant of patient symptoms, functional capacity, and long-term prognosis, making its accurate assessment and monitoring a central tenet of contemporary cardiology. Transthoracic echocardiography stands as the primary, non-invasive, and widely accessible imaging modality for

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the comprehensive evaluation of cardiac structure and function in CAD patients. It provides indispensable parameters such as left ventricular ejection fraction (LVEF), the cornerstone for classifying heart failure and guiding therapy; LV volumes, which indicate remodeling; and Doppler-based indices like the E/e' ratio, a key marker of LV filling pressures and diastolic function.[3,4] Serial echocardiographic evaluation is, therefore, instrumental in diagnosing complications, assessing therapeutic efficacy, and stratifying risk throughout the disease continuum. The management of stable CAD is fundamentally anchored in guideline-directed medical therapy (GDMT), which includes antiplatelet agents, statins, beta-blockers, and renin-angiotensin-aldosterone system inhibitors. These pharmacotherapies are proven to reduce ischemic events, attenuate adverse LV remodeling, and improve survival.[5,6] While the long-term benefits of GDMT on mortality and morbidity are unequivocally established from landmark trials spanning decades, the trajectory of echocardiographic changes within the initial months of treatment in a real-world clinical cohort is less exhaustively documented. Most evidence derives from post-myocardial infarction studies or heart failure trials, leaving a gap in knowledge regarding the short-term functional response in a broader, heterogeneous CAD population under routine care.[7,8] Preliminary studies suggest that modern, optimized GDMT can induce favorable cardiac geometrical and functional changes earlier than previously recognized. For instance, recent investigations have reported measurable improvements in LVEF and global longitudinal strain within 3 to 6 months of intensified medical therapy.[9,10] Furthermore, the regression of LV hypertrophy and improvement in diastolic parameters are also achievable therapeutic goals, reflecting reverse remodeling.[11] However, the consistency and magnitude of these early changes in different healthcare settings, particularly in regions with distinct patient demographics and healthcare delivery systems like South Asia, warrant further elucidation. In Bangladesh, the rising prevalence of CAD and its risk factors presents a significant public health challenge.[12] Data on the systematic monitoring of cardiac function with echocardiography during the critical early phase of treatment in this population are sparse. Understanding this short-term trajectory is vital for reinforcing adherence to therapy, optimizing resource allocation for follow-up, and potentially identifying non-responders who may require advanced interventions. Therefore, this study aimed to prospectively evaluate the changes in key echocardiographic parameters of cardiac function among patients with CAD over a standardized 12-week treatment period with GDMT at a tertiary care center in Dhaka, Bangladesh.

Methods

This prospective cohort study was conducted at the Department of Cardiology, International Medical College, Dhaka, over 12 months (January to December 2023). The study population consisted of 63 adult patients with a confirmed diagnosis of coronary artery disease (CAD), defined by prior documentation of >70% stenosis in a major coronary artery on angiography or a history of revascularization (PCI/CABG).

Inclusion criteria: Patients aged 18-75 years, of both sexes, with stable CAD on standard guideline-directed medical therapy (GDMT) were eligible. All participants provided written informed consent before enrolment.

Exclusion criteria: Key exclusions were: acute coronary syndrome within the preceding 3 months,

significant primary valvular heart disease, cardiomyopathies not secondary to CAD, chronic kidney disease (eGFR <30 mL/min/1.73m²), poor echocardiographic windows, and any condition limiting 12-week follow-up.

Study procedure: Using purposive sampling, eligible participants were enrolled. A comprehensive transthoracic echocardiogram (TTE) was performed at baseline (Week 0) and repeated after 12 weeks of continued GDMT. All examinations were conducted by experienced sonographers using a standardized protocol. Measurements of left ventricular ejection fraction (LVEF) and volumes (LVEDV, LVESV) were obtained following contemporary chamber quantification guidelines.[3] Diastolic function was assessed per the 2016 ASE/EACVI recommendations, with the E/e' ratio calculated as the ratio of the early diastolic mitral inflow velocity (E) to the average of the septal and lateral mitral annular early diastolic velocities (e').[4]

Data analysis: Data were analyzed using SPSS software (Version 23.0). Paired-sample t-tests were used to compare continuous echocardiographic parameters between baseline and 12 weeks, with statistical significance set at $p < 0.05$. Results are presented as mean ± standard deviation (SD).

Results

A total of 63 patients with coronary artery disease (CAD) were enrolled and completed the 12-week follow-up. The mean age of the study population was 58.7 years (SD ±9.2), with a majority being male (68.3%). The most prevalent cardiovascular risk factors were hypertension (71.4%) and dyslipidemia (66.7%), followed by diabetes mellitus (49.2%). A history of smoking was reported by 41.3% of participants. Regarding CAD history, 52.4% had undergone percutaneous coronary intervention (PCI), 22.2% had a history of coronary artery bypass grafting (CABG), and the remaining 25.4% were on optimal medical therapy alone. The baseline pharmacological regimen was consistent with standard guidelines, with high utilization rates of antiplatelets (100%), statins (98.4%), beta-blockers (87.3%), and ACE inhibitors/ARBs (81.0%). The primary echocardiographic outcomes demonstrated significant improvements in cardiac function over the 12-week treatment period. The mean left ventricular ejection fraction (LVEF) increased significantly from 45.2% at baseline to 49.5% at follow-up. Concomitantly, left ventricular volumes showed favorable changes: the left ventricular end-systolic volume (LVESV) decreased from 68.5 mL to 62.1 mL, and the left ventricular end-diastolic volume (LVEDV) showed a trend towards reduction, from 143.2 mL to 138.9 mL. Diastolic function, as assessed by the average E/e' ratio, also improved significantly, declining from 12.4 to 10.8. Further stratification of the cohort based on baseline LVEF revealed differential responses. Patients with reduced LVEF (<50%) at baseline experienced a more pronounced absolute improvement in LVEF compared to those with preserved LVEF (≥50%). The mean increase was substantial in the reduced EF group, while the change in the preserved EF group was minimal and not statistically significant. Similar patterns were observed for LVESV reduction. The analysis of changes in diastolic function parameters also showed significant improvements. The lateral e' velocity increased, and the left atrial volume index (LAVI) decreased significantly from baseline to 12 weeks. When participants were categorized by their E/e' ratio at baseline, those with elevated filling pressures (E/e' ≥14) demonstrated a significant decrease in this ratio, whereas the group with normal filling pressures (E/e' <14) maintained stable values.

Table 1: Baseline demographic and clinical characteristics of study participants (N=63)

Characteristic	Value
Age (years), Mean ± SD	58.7 ± 9.2
Sex, n (%)	
Male	43 (68.3%)
Female	20 (31.7%)
Cardiovascular risk factors, n (%)	
Hypertension	45 (71.4%)
Diabetes mellitus	31 (49.2%)
Dyslipidemia	42 (66.7%)
Current or former smoker	26 (41.3%)
CAD History, n (%)	
Prior PCI	33 (52.4%)
Prior CABG	14 (22.2%)
Medical therapy only	16 (25.4%)
Baseline medications, n (%)	
Antiplatelet(s)	63 (100%)
Statin	62 (98.4%)
Beta-blocker	55 (87.3%)
ACE inhibitor / ARB	51 (81.0%)

Table 2: Echocardiographic parameters at baseline and 12-week follow-up

Parameter	Baseline	12-week	p-value
	(Mean ± SD)		
LVEF (%)	45.2 ± 7.8	49.5 ± 8.1	0.003
LVEDV (mL)	143.2 ± 28.5	138.9 ± 26.8	0.092
LVESV (mL)	68.5 ± 15.2	62.1 ± 14.7	0.010
Average E/e' ratio	12.4 ± 3.1	10.8 ± 2.9	0.020

Statistical test: Paired Samples t-test.

Table 3: Change in LVEF stratified by baseline ejection fraction

Baseline LVEF category	n	Baseline LVEF (%)	12-Week LVEF (%)	Absolute change	p-value
Reduced EF (<50%)	38	40.1 ± 5.2	45.8 ± 6.0	+5.7 ± 3.1	<0.001
Preserved EF (≥50%)	25	53.1 ± 2.5	53.5 ± 2.8	+0.4 ± 1.5	0.215

Statistical test: Paired Samples t-test within each group.

Table 4: Change in LVESV stratified by baseline ejection fraction

Baseline LVEF category	n	Baseline LVESV	12-Week LVESV	Absolute change	p-value
		mL			
Reduced EF (<50%)	38	75.8 ± 12.4	67.3 ± 13.1	-8.5 ± 6.2	<0.001
Preserved EF (≥50%)	25	57.2 ± 8.9	54.8 ± 9.6	-2.4 ± 5.1	0.058

Statistical test: Paired Samples t-test within each group.

Table 5: Diastolic function parameters at baseline and 12-week follow-up

Parameter	Baseline	12-Week	p-value
	(Mean ± SD)		
Lateral e' velocity (cm/s)	7.2 ± 1.8	8.1 ± 1.9	0.005
Septal e' velocity (cm/s)	6.5 ± 1.6	7.0 ± 1.7	0.051
Average E/e' ratio	12.4 ± 3.1	10.8 ± 2.9	0.020
Left Atrial Volume Index (LAVI), mL/m²	33.6 ± 7.2	31.1 ± 6.8	0.015

Statistical test: Paired Samples t-test.

Table 6: Change in E/e' ratio stratified by baseline diastolic function

Baseline E/e' category	n	Baseline E/e'	12-Week E/e'	Absolute change	p-value
Elevated Filling Pressure (E/e' ≥ 14)	18	16.1 ± 1.9	13.2 ± 2.1	-2.9 ± 1.5	<0.001
Normal Filling Pressure (E/e' < 14)	45	10.8 ± 1.5	10.1 ± 1.7	-0.7 ± 1.2	0.001

Statistical test: Paired Samples t-test within each group.

Discussion

This prospective cohort study demonstrates that a 12-week course of guideline-directed medical therapy (GDMT) in patients with stable coronary artery disease (CAD) is associated with significant, early improvements in key echocardiographic indices of both systolic and diastolic function. The observed increase in LVEF and reduction in LVESV signify favorable reverse LV remodeling. At the same time, the decline in the E/e' ratio and LAVI indicates amelioration of diastolic dysfunction and left atrial pressure. These findings align with the established cardioprotective goals[13] of GDMT and underscore that meaningful echocardiographic benefits can be detected within a relatively short timeframe in a real-world clinical setting. The significant improvement in mean LVEF (from 45.2% to 49.5%) and the pronounced reduction in LVESV, particularly in the subgroup with baseline reduced EF, are the most salient findings. This is consistent with the known mechanisms of core heart failure medications. Beta-blockers and renin-angiotensin-aldosterone system (RAAS) inhibitors mitigate neurohormonal activation, reduce myocardial oxygen demand, and decrease wall stress, thereby promoting reverse remodeling and enhancing contractile efficiency.[5,14] Our results corroborate previous studies that reported measurable gains in LVEF within 3 to 6 months of optimized therapy, extending this evidence to a purposively sampled cohort in a South Asian context.[9,15] The more modest change in LVEDV suggests that early reverse remodeling may be initiated through a reduction in systolic volume (improved emptying) before a significant reduction in chamber size occurs. Equally important are the observed improvements in diastolic parameters. The significant decrease in the average E/e' ratio, a reliable non-invasive surrogate for left ventricular filling pressure, and the reduction in LAVI, a marker of chronic LV filling pressure exposure, indicate enhanced myocardial relaxation and compliance.[4,16] This diastolic benefit is a crucial but often underemphasized aspect of CAD management, as diastolic dysfunction is a strong predictor of adverse outcomes independent of systolic function.[17] The stratification analysis (Table 6) revealed that patients

with elevated filling pressures at baseline experienced the greatest improvement, highlighting the potential for targeted therapeutic efficacy in this high-risk subgroup. The differential response based on baseline LVEF status provides valuable clinical insight. Patients with reduced EF exhibited substantial functional recovery, reinforcing the imperative for aggressive and timely GDMT initiation in this group. In contrast, those with preserved EF showed stable parameters, which can itself be considered a positive outcome, preventing the progression to overt heart failure.[18] This differential response validates the pathophysiological premise that patients with more compromised myocardium have greater potential for measurable improvement with evidence-based interventions. Our study has several limitations. The purposive sampling technique and single-center design limit the generalizability of the findings. The relatively small sample size of 63, while sufficient for paired analyses, may not have powered the detection of more subtle changes or allowed for extensive multivariate analysis to adjust for all potential confounders. The absence of a control group not on optimized GDMT, while ethically challenging, means we cannot definitively attribute all changes solely to the treatment versus natural history. Furthermore, the 12-week duration, while demonstrating early benefits, cannot inform on the sustainability or long-term trajectory of these echocardiographic improvements. Despite these limitations, our study has significant strengths, including its prospective design, standardized echocardiographic protocol adhering to international guidelines, and high follow-up completion rate. The findings carry important implications for clinical practice in settings like Bangladesh, where CAD prevalence is rising.[12] They provide objective, early evidence of therapeutic efficacy that can reinforce patient and physician commitment to adherence. They also support the utility of short-interval echocardiographic re-assessment, particularly in patients with reduced EF or elevated filling pressures, to monitor treatment response and potentially guide therapy intensification. This study confirms that structured 12-week GDMT leads to significant early echocardiographic evidence of reverse cardiac remodeling and improved diastolic function in patients with CAD. These results emphasize the tangible functional benefits of guideline-concordant care and advocate for the integration of serial echocardiographic evaluation into the routine management strategy to optimize outcomes for CAD patients.

Limitations

This study's findings are limited by its single-center design, purposive sampling, and relatively small sample size, which may affect generalizability. The absence of a control group precludes definitive causal attribution of echocardiographic changes solely to medical therapy. A longer follow-up duration would be needed to assess the sustainability of the observed benefits.

Conclusion

In patients with stable coronary artery disease, 12 weeks of guideline-directed medical therapy result in significant early echocardiographic improvements in systolic and diastolic function, indicating favorable reverse remodeling. These objective findings reinforce the tangible benefits of structured medical therapy and support the clinical utility of short-interval echocardiographic re-assessment to monitor treatment response and potentially guide management, especially in patients with initially compromised cardiac function.

Recommendation

Based on the findings, we recommend the integration of a 12-week follow-up echocardiogram into routine CAD management protocols to objectively assess early therapeutic response. Particular emphasis should be placed on monitoring patients with initially reduced ejection fraction or elevated filling pressures, as they demonstrate the most significant functional improvement with optimized guideline-directed therapy.

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