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Original Research Article

Echocardiographic Evaluation of Left Ventricular Function in Patients with Acute Myocardial Infarction: A Hospital-Based Study of 150 Cases

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Abstract

Background: Left ventricular (LV) function assessment is crucial in patients with acute myocardial infarction (AMI), as both systolic and diastolic dysfunction are known predictors of early in-hospital heart failure. Two-dimensional (2D) echocardiography provides a non-invasive and reliable method to evaluate LV performance and risk stratify patients. This study aimed to assess the prevalence of systolic and diastolic dysfunction in acute STEMI and correlate these findings with clinical risk factors and early heart failure.

Material and Methods: This hospital-based observational study included 150 patients with acute ST-elevation myocardial infarction (STEMI) admitted to the Intensive Coronary Care Unit. All patients underwent 2D and Doppler echocardiography within 48 hours of admission. LV ejection fraction (LVEF), regional wall motion score index (RWMI), and diastolic function grading were assessed. Clinical data including age, sex, infarct type, diabetes, smoking status, and Killip classification were recorded. Heart failure was defined as Killip class ≥ II. Statistical analysis included univariate and multivariate logistic regression to identify predictors of early heart failure.

Results: Among 150 patients, 72.7% were male and 58% were aged between 51–60 years. Anterior MI was observed in 64% of cases. LVEF was significantly lower in anterior MI (42.4%) than inferior MI (47.8%, $p = 0.034$), while RWMI was significantly higher in anterior MI (1.56 vs. 1.31, $p = 0.001$). Diastolic dysfunction was found in 47.3% of patients, mostly Grade I. Early heart failure occurred in 29.3% of patients and was significantly associated with diabetes, smoking, lower LVEF, and diastolic dysfunction. In multivariate analysis, only LVEF ≤ 40% (OR = 13.7, $p = 0.002$) and diastolic dysfunction (OR = 5.6, $p = 0.030$) remained independent predictors of heart failure.

Conclusion: Early echocardiographic evaluation in STEMI patients provides vital prognostic information. Reduced LVEF and diastolic dysfunction were the most reliable predictors of early in-hospital heart failure. Clinical factors such as diabetes and smoking further contributed to adverse outcomes. Timely risk stratification using echocardiography can help guide early therapeutic interventions in acute MI management.

Keywords: ST-elevation myocardial infarction, 2D echocardiography, left ventricular dysfunction, LVEF, diastolic dysfunction.

Introduction

Acute Myocardial Infarction (AMI) continues to be one of the leading causes of morbidity and mortality globally. [1] Left ventricular (LV) dysfunction, both systolic and diastolic, is a significant determinant of early and long-term outcomes in these patients.[2]

Ventricular arrhythmias, cardiogenic shock, and congestive heart failure are commonly associated with impaired LV function following AMI and contribute heavily to in-hospital complications and long-term prognosis. [3] Echocardiography is the most widely available and non-invasive method for assessing cardiac structure and function. [4] Two-dimensional (2D) echocardiography provides critical information about left ventricular ejection fraction (LVEF), regional wall motion abnormalities (RWMA), and chamber dimensions, while Doppler techniques allow the evaluation of diastolic function by analyzing trans-mitral flow patterns and filling pressures. [5]

Several clinical and demographic factors such as age, sex, smoking status, diabetes, hypertension, and Killip class [6] are known to influence the extent of myocardial damage and subsequent

ventricular dysfunction. [7] Among the subtypes of myocardial infarction, anterior wall MI has been consistently associated with greater myocardial loss and more severe LV dysfunction. [8]

Given the clinical importance of LV function as a prognostic indicator, this study was undertaken to evaluate the prevalence and pattern of systolic and diastolic dysfunction using 2D echocardiography in patients presenting with acute ST-elevation myocardial infarction (STEMI), and to explore its association with cardiovascular risk factors and early in-hospital development of congestive heart failure.

Material and Methods

This was a hospital-based observational study conducted in the Intensive Coronary Care Unit (ICCU) of a tertiary care teaching hospital. A total of 150 patients, aged between 30 to 60 years, admitted with a first episode of acute ST-elevation myocardial infarction (STEMI) were enrolled over a period from February 2019 to December 2020. The diagnosis of STEMI was confirmed by clinical history, ECG changes, and elevated cardiac biomarkers. Patients were evaluated within 48 hours of admission using two-dimensional (2D) and Doppler echocardiography. Patients with prior myocardial infarction, known heart failure, valvular heart disease, cardiomyopathy, or poor echocardiographic window were excluded from the study.

All enrolled patients underwent comprehensive echocardiographic examination. Left ventricular systolic function was assessed by measuring the ejection fraction (LVEF) using the biplane Simpson's method, and regional wall motion abnormalities (RWMA) were identified and categorized as normal, hypokinetic, severely hypokinetic or akinetic, dyskinetic, or aneurysmal. Wall Motion Score Index (WMSI) was calculated using the 16-segment model recommended by the American Society of Echocardiography, where a score of 1 denotes normal function and higher values indicate greater dysfunction. Diastolic function was assessed using Doppler echocardiography to evaluate trans-mitral flow velocities and pressure gradients. Based on these findings, diastolic dysfunction was graded as Grade I (impaired relaxation), Grade II (pseudonormal), Grade III (reversible restrictive), or Grade IV (irreversible restrictive) filling pattern.

Demographic and clinical data including age, sex, smoking status, diabetes mellitus, systemic hypertension, type of myocardial infarction (anterior or inferior wall), and Killip class at admission were recorded for each patient. All patients were managed as per standard treatment protocols, including thrombolysis with streptokinase, beta-blockers, and ACE inhibitors. Patients were monitored daily throughout their hospital stay for development of congestive heart failure, which was defined as Killip class II or above. The worst Killip class recorded during hospitalization was used for analysis.

Data were analyzed using SPSS version 20.0. Continuous variables were presented as mean ± standard deviation (SD), and categorical variables as percentages. Statistical tests including Chi-square test, Student's t-test, Mann-Whitney U test, and ANOVA were used for group comparisons. Receiver Operating Characteristic (ROC) curve analysis was used to assess the diagnostic performance of echocardiographic parameters in predicting early in-hospital heart failure. Univariate and multivariate logistic regression analyses were conducted to identify independent predictors. A p-value of <0.05 was considered statistically significant. The study was approved by the Institutional Ethics Committee, and written informed consent was obtained from all participants before inclusion in the study. All procedures were conducted in accordance with the ethical standards.

Results

A total of 150 patients diagnosed with acute ST-elevation myocardial infarction (STEMI) were included in the study. Of these, 109 (72.7%) were male and 41 (27.3%) were female. The age distribution ranged from 30 to 60 years, with the majority of patients (58%) falling within the 51–60 age group. Males were more commonly affected across all age groups, particularly in anterior wall MI.

Table 1: Patient Distribution

Variable	Number (n=150)	Percentage (%)
Total Patients	150	100%
Male	109	72.70%
Female	41	27.30%
Age 30 - 40	18	12.00%
Age 41 - 50	45	30.00%
Age 51 - 60	87	58.00%
Anterior MI	96	64.00%
Inferior MI	54	36.00%
Diabetics	55	36.70%
Smokers	68	45.30%
Heart Failure (Killip ≥ II)	44	29.30%

Among the 150 patients, anterior wall MI was observed in 96 cases (64%), while inferior wall MI occurred in 54 cases (36%). The mean age in the anterior MI group was 51.3 ± 6.5 years, compared to 52.1 ± 6.9 years in the inferior MI group ($p > 0.05$). Males had a higher incidence of anterior MI, although the difference was not statistically significant ($p = 0.310$). The mean systolic blood pressure was higher in anterior MI patients (132.6 ± 25.8 mmHg) compared to inferior MI patients (117.9 ± 29.4 mmHg), though this also did not reach statistical significance ($p = 0.058$).

All patients underwent 2D echocardiography within 48 hours of admission. Regional wall motion abnormalities were detected in 100% of cases. The mean Left Ventricular Ejection Fraction (LVEF) was significantly lower in the anterior MI group (42.4 ± 10.8%) compared to the inferior MI group (47.8 ± 12.2%, $p = 0.034$). Similarly, the Regional Wall Motion Score Index (RWMI) was significantly higher in anterior MI (1.56 ± 0.32) vs. inferior MI (1.31 ± 0.09), with a p-value of 0.001. However, LV end-diastolic diameter (LVEDD) and LV end-systolic diameter (LVESD) showed no statistically significant difference between the two groups ($p > 0.05$). Diastolic dysfunction was present in 71 patients (47.3%), while 79 patients (52.7%) had normal LV filling patterns. Among those with diastolic dysfunction, 61 (86%) had Grade I, and 10 (14%) had Grade II patterns. None of the patients demonstrated Grade III or IV filling patterns. Distribution of diastolic dysfunction was not significantly different between the anterior and inferior MI groups ($p > 0.05$). The incidence of early in-hospital heart failure (Killip class ≥ II) was observed in 44 patients (29.3%). The prevalence of heart failure was higher among older age groups, diabetic patients, and smokers. Patients with heart failure had significantly longer ICCU stays (2.9 ± 0.8 days vs. 2.4 ± 0.6 days, $p = 0.041$), though total hospital stay was not significantly different.

Among clinical risk factors, diabetes mellitus was present in 37 of the 44 heart failure patients (84.1%) compared to 13.8% in non-heart failure patients ($p = 0.012$). Similarly, smoking was more prevalent among heart failure patients (75%) than those without heart failure (28.6%, $p = 0.038$). Systolic blood pressure at admission was lower in the heart failure group (121.3 ± 26.1 mmHg) than in the non-heart failure group (135.4 ± 27.2 mmHg), although this difference was not statistically significant ($p = 0.064$).

Table 2: Echocardiographic parameters in MI types

Parameter	Anterior MI (n=96) Mean ± SD	Inferior MI (n=54) Mean ± SD	p-value
LVEF (%)	42.4 ± 10.8	47.8 ± 12.2	0.034
LVEDD (cm)	4.76 ± 0.81	4.58 ± 0.88	0.441
LVESD (cm)	3.77 ± 0.79	3.42 ± 0.91	0.163
RWMI	1.56 ± 0.32	1.31 ± 0.09	0.001

Echocardiographic parameters showed a strong correlation with development of heart failure. Patients with LVEF ≤ 40% had significantly higher rates of heart failure (OR = 22.1, $p < 0.001$), followed by those with diastolic dysfunction (OR = 6.4, $p = 0.006$) and elevated RWMI (>1.7) (OR = 7.2, $p = 0.041$). In multivariate logistic regression, only LVEF ≤ 40% (adjusted OR = 13.7, $p = 0.002$) and diastolic dysfunction (adjusted OR = 5.6, $p = 0.030$) remained significant independent predictors. RWMI lost statistical significance, likely due to collinearity with LVEF.

Discussion

In our study comprising 150 patients with acute STEMI, a significant male predominance was observed, with 72.7% males and 27.3% females. This closely mirrors the findings of Makawana et al. (2023) [9], who reported a similar gender distribution of 72% males and 28% females. Comparable trends have been documented in studies by Shivpuje et al. (2017) [10] and Kodilkar et al. (2014) [11], emphasizing that men are more frequently affected by myocardial infarction. The likely explanations include greater exposure to cardiovascular risk factors such as smoking, sedentary lifestyle, and psychosocial stress, in addition to the cardioprotective role of estrogen in premenopausal women. The age distribution in our study showed that the majority of patients (58%) belonged to the 51–60 year age group. This is in agreement with the findings of Makawana et al. (2023) [9]and Shivpuje et al. (2017) [10], both of whom reported peak incidence in similar age ranges. As age advances, the accumulation of atherosclerotic burden and longer exposure to risk factors contribute significantly to the development of AMI. Notably, males were more frequently affected in anterior wall infarctions across all age brackets in our study. These findings highlight the need for aggressive risk factor screening and preventive strategies, particularly in middle-aged populations. In our study, anterior wall myocardial infarction (MI) was more commonly observed, accounting for 64% of cases, whereas inferior wall MI occurred in 36%. This anterior predominance is in line with findings from Shivpuje et al. (2017) [10]. who reported anterior MI in 58% of their cases, suggesting a consistent trend across different populations. The mean age in the anterior MI group

was slightly lower than in the inferior group (51.3 vs. 52.1 years), though not statistically significant. Males showed a higher incidence of anterior MI, but the gender difference did not reach significance ($p = 0.310$). A higher mean systolic blood pressure was also noted in anterior MI cases (132.6 ± 25.8 mmHg), compared to inferior MI (117.9 ± 29.4 mmHg), although this difference, too, was not statistically significant ($p = 0.058$).

In our study, all patients showed regional wall motion abnormalities (RWMA), confirming the utility of early 2D echocardiography in STEMI. LVEF was significantly lower in anterior MI patients (42.4%) compared to inferior MI (47.8%, $p = 0.034$), aligning with McClements et al. (2000) [12], who also noted reduced LVEF in anterior infarcts. RWMI was significantly higher in anterior MI (1.56 vs. 1.31), reflecting greater functional impairment, consistent with Espersen et al. (2022) [13]. LVEDD and LVESD showed no significant difference between the groups, suggesting limited acute structural changes. [14]

In our study, diastolic dysfunction was observed in 47.3% of patients, predominantly Grade I, with no cases of Grade III or IV. This distribution is comparable to findings by Whalley et al. (2006) [15], who linked restrictive filling patterns with poorer outcomes. The absence of severe diastolic grades may reflect early-stage dysfunction or exclusion of prior cardiac disease. No significant difference was noted in diastolic dysfunction between anterior and inferior MI, consistent with findings by Nagueh et al. (2016) [16] that diastolic dysfunction can occur independently of infarct location.

Early in-hospital heart failure occurred in 29.3% of our patients, a rate comparable to that reported in the VALIANT trial and studies like Yuasa et al. (2005) [17]. Heart failure was more frequent in older individuals, diabetics, and smokers. ICCU stay was significantly longer in heart failure patients ($p = 0.041$), though total hospital stay was not. This supports earlier findings that Killip class ≥ II is associated with worse in-hospital progression, even without structural differences in hospital course duration.

Diabetes and smoking were strongly associated with heart failure in our cohort, with diabetic patients nearly seven times more likely to develop CHF ($p = 0.012$), similar to trends seen in McClements et al. (2000)12. Smoking also showed a significant correlation ($p = 0.038$), reinforcing its role as a modifiable risk. Although systolic BP was lower in the heart failure group, the difference was not statistically significant — a pattern often seen in patients developing cardiogenic shock or early decompensation.

Our study demonstrated that echocardiographic parameters—particularly left ventricular ejection fraction (LVEF), diastolic dysfunction, and regional wall motion score index (RWMI)—were significantly associated with early in-hospital heart failure. Among these, a reduced LVEF (≤40%) emerged as the strongest independent predictor (adjusted OR = 13.7, $p = 0.002$), which is consistent with findings from Makawana et al. (2023) [9], who reported an area under the curve (AUC) of 0.862 for LVEF in predicting heart failure, underscoring its excellent diagnostic accuracy. Similarly, another study found LVEF to be superior to other echocardiographic markers, including transmitral filling parameters and myocardial performance index (MPI), in forecasting heart failure within the first two weeks post-MI. Diastolic dysfunction also showed a significant independent association with heart failure in our study (adjusted OR = 5.6), which echoes the conclusions of Whalley et al. (2006) [15], whose meta-analysis revealed a fourfold increase in mortality among post-MI patients with restrictive diastolic filling. Our findings are further supported by Milwidsky et al. (2022) [18], who introduced the echocardiographic Killip (eKillip) classification and emphasized the prognostic value of diastolic grade and stroke volume index in mortality prediction. While RWMI was significantly associated with heart failure in univariate analysis (OR = 7.2, $p = 0.041$), it did not retain significance in the multivariate model, likely due to collinearity with LVEF. This observation is aligned with McClements et al. (2000) [12], who highlighted the strong interdependence between RWMI and LVEF, noting that RWMI does not provide additional prognostic value once LVEF is accounted for. Collectively, these findings reaffirm that LVEF and diastolic function—rather than RWMI alone—are more robust and independently reliable predictors of early heart failure in acute MI settings.

The study was limited by its single-center design and modest sample size, which may affect generalizability. Advanced grades of diastolic dysfunction and long-term outcomes were not evaluated. Exclusion of patients with prior cardiac disease may have underestimated the broader clinical variability.

Conclusion

In this hospital-based observational study, 2D echocardiography proved to be an essential, early diagnostic tool for evaluating left ventricular function in patients with acute ST-elevation myocardial infarction. Anterior wall infarction was more commonly associated with significant systolic dysfunction, while nearly half of the patients demonstrated varying degrees of diastolic dysfunction. Among the echocardiographic

parameters, reduced LVEF and diastolic dysfunction emerged as the most significant independent predictors of early in-hospital heart failure. Clinical factors such as diabetes mellitus and smoking were also strongly associated with poor outcomes. These findings emphasize the utility of early echocardiographic assessment not only for diagnostic evaluation but also for prognostication and risk stratification in acute MI care. Future studies with larger, more diverse populations are warranted to refine these associations and guide individualized therapeutic decisions.

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