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Evaluation Of Left Ventricular Systolic Function In Patients With Acute Myocardial Infarction: A Cross-Sectional Study

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Abstract:
Background: This study aimed to assess the longitudinal changes in left ventricular (LV) systolic function among patients who underwent primary percutaneous coronary intervention (PCI) for acute myocardial infarction (MI), categorized by the affected vessel.
Methods: A cohort study included 158 patients who received primary angioplasty for acute MI. Each patient had a baseline echocardiographic evaluation utilizing M-mode, two-dimensional measurements, and strain and strain rate assessments. Participants were monitored over a month to evaluate changes in LV systolic function.
Results: After one-month post-revascularization, a noteworthy improvement in global LV strain was observed (p-value = 0.05). Patients who experienced major adverse cardiac events (MACE) showed a significant reduction in Left Ventricular Global Longitudinal Strain (LV GLS) compared to those without events. Additionally, values for the Wall Motion Score Index and LV end-systolic volume were substantially elevated in the MACE group versus the event-free group.
Conclusion: The findings reveal an enhancement in LV systolic function, measured via speckle tracking echocardiography, exceeding that of left ventricular ejection fraction (LVEF) regardless of the culprit vessel. MACE was reported in 4.4% of the acute MI patients even after successful PCI. Baseline LV EF

and Wall Motion Score Index were identified as independent predictors of MACE at the one-month follow-up, more so than LV strain.
Key words: Acute myocardial infarction, Major adverse cardiac events, Echocardiography.

INTRODUCTION

Cardiovascular disease ranks as one of the top causes of death in the general populace. Acute coronary syndromes (ACS) are significant contributors to the mortality rates linked with cardiovascular conditions. Achieving restoration of blood flow through the affected artery via percutaneous coronary intervention (PCI) leads to the recovery of left ventricular (LV) function, which can be assessed using various systolic function parameters [1]. Regardless of the chosen treatment, the incidence of major adverse cardiac events (MACE) ranges between 4.2% and 51%, with follow-up studies extending for up to 10 years after the diagnosis of ST-Elevation Myocardial Infarction (STEMI) [2]. Major adverse cardiac events encompass complications such as strokes arising from thrombotic embolism, fatalities due to cardiac rupture or severe arrhythmias like ventricular tachycardia (VT) or ventricular fibrillation (VF), as well as heart failure leading to pulmonary oedema. Additional complications may consist of non-fatal re-infarction, recurring chest pain, hospital admissions for cardiac issues, and the need for repeated reperfusion therapies or coronary artery bypass grafting (CABG). Patients demonstrating adverse LV remodelling face an increased likelihood of experiencing major adverse cardiac events after reperfusion. The extent of LV dilation or remodelling post-myocardial infarction (MI) or in patients with heart failure serves as a strong indicator of both morbidity and mortality. Assessing global systolic function, including ejection fraction (EF) and wall motion score index (WMSI), is vital for determining risk among individuals with an MI [3-5]. Speckle tracking echocardiography is instrumental in evaluating sub-endocardial damage, providing a unique insight into myocardial structure throughout the cardiac cycle, regardless of the assessment angle. This method is an exceptional predictor of adverse LV remodelling and subsequent cardiac events in specific patient groups. By examining the effectiveness of LV strain measurements taken before discharge compared to those taken one month later, we can gain important insights for clinical practice. Furthermore, evaluating LV strain within a clinical context to predict major adverse cardiac events can enhance risk stratification and improve survival rates among post-MI patients.

MATERIALS AND METHODS:

This cohort study occurred in the Cardiology department of Private Medical College, Chennai, from January 2023 to November 2024. The study received ethical approval from an Institutional Ethics Committee (IEC) and adhered to the principles outlined in the Declaration of Helsinki throughout its implementation. Participants included in the study were those who had undergone revascularization for acute myocardial infarction (MI). However, individuals with a history of revascularization, heart failure, stroke, malignant tumours, metastasis, pre-existing ventricular dysfunction, significant primary valvular lesions, or chronic kidney disease (CKD) were excluded from the research. Patients were recruited based on the inclusion criteria after informed consent was obtained. A thorough clinical history was collected, which encompassed details such as age, gender, height, weight, body mass index (BMI), history of hypertension, diabetes, smoking or alcohol use, and any prior heart problems. The culprit vessel was identified by analyzing ECG and angiogram reports. Baseline echocardiographic data were recorded using appropriate equipment, capturing standard cardiac imaging views, including the parasternal long axis and short axis at three levels of the left ventricle (LV), as well as apical 4, 3, and 2 chamber views, alongside the respective electrocardiogram (ECG) recordings. Left ventricular ejection fraction (LVEF) was measured using M-mode and Simpson's volumetric method. Left ventricular end-diastolic volume (LVEDV) and left ventricular end-systolic volume (LVESV) were determined by manually tracing the endocardial border during diastole and systole, respectively. Echocardiographic images were retained for future offline analysis. The wall motion score index (WMSI) was calculated using short axis views (basal, mid, apical) by evaluating the systolic movement of each segment and assigning a corresponding score, with WMSI computed as the total wall motion scores divided by the number of segments. Using semi-automatic software, two-dimensional speckle tracking was performed on apical views (4 chambers, 2

chambers, and 3 chambers). This analysis involved manually delineating the endocardial border and adjusting the region of interest based on myocardial thickness. After selecting the region of interest, the software automatically generated strain and strain rate curves for different areas and a Bull's eye representation of the 17 segments. Strain rates were recorded during peak systole, early diastole, and late diastole. Global longitudinal strain (GLS) was calculated as the average of the worldwide peak systolic strain from the three views. Of the 158 patients, 64 had regular follow-up visits, during which all parameters were re-evaluated and adverse outcomes noted. The other patients were contacted via telephone to assess any adverse events and evaluate their overall quality of life. The collected data were analyzed using the Statistical Package for Social Sciences (SPSS) software. Continuous normally distributed variables were expressed as Mean ± SD and compared using paired sample t-tests. In contrast, those not normally distributed were represented as median with interquartile range (IQR) and analyzed using paired sample statistics. Categorical data were presented as frequencies and percentages. Repeated measures of ANOVA were conducted to compare the longitudinal changes in LV systolic function across three culprit vessel subgroups. A receiver operating characteristic (ROC) analysis was performed on LVEF, WMSI, and LV strain to predict major adverse cardiac events (MACE). The area under the curve, a 95% confidence interval, and optimal cutoff points were calculated. A multivariable binary logistic regression was employed to assess composite and individual outcomes of major adverse cardiac events among patients post-primary percutaneous coronary intervention (PCI). A p-value of less than 0.05 was considered statistically significant.

RESULTS

The study included 158 patients who underwent primary PCI due to myocardial infarction, all providing informed consent. The participants had an average age of 54.18±11.12 years, with a gender distribution of 98 males (62%) and 60 females (38%). Among these individuals, 25 (15.8%) were diagnosed with hypertension, and 96 (60.7%) were diabetic. A history of smoking was present in 33 patients (20.8%), 37 (23.4%) had a history of alcohol consumption, and 38 (24%) had a family history of coronary artery disease (CAD). The electrocardiographic data indicated that the left anterior descending artery (LAD) was the most frequently implicated vessel, affecting 55 patients (34.8%), followed by the right coronary artery (RCA) in 82 patients (31.8%) and the left circumflex artery (LCx) in 21 patients (8.1%). We compared the changes in left ventricular (LV) systolic parameters and the incidence of major adverse cardiac events (MACE) from baseline to one-month follow-up across the three culprit vessels. The findings indicate that global LV strain was more significantly diminished when the LAD was affected. Notably, there was an overall improvement in global LV strain between baseline and follow-up assessments, regardless of the specific coronary artery involved. Baseline left ventricular ejection fraction (LVEF) was lower in patients with LAD involvement than those with other vessels. Improvements in LVEF were noted in all three groups from baseline to follow-up, but no significant differences were observed between them. Patients with LAD as the culprit vessel exhibited higher baseline values for left ventricular end-diastolic volume (EDV) (84.21 ±12.7) and wall motion score index (WMSI) (1.88 ± 0.45). The occurrences of MACE were also more prevalent in the LAD group (5 patients, 3.1%), followed by the RCA group (2 patients, 1.2%), while no events were recorded in the LCx group. Patients with LAD as the culprit vessel demonstrated systolic and diastolic function deterioration, whereas echocardiographic findings remained stable in RCA and LCx patients. The traditional echocardiographic parameters observed at baseline and follow-up. Significant differences were noted in left ventricular dimensions, including LV fractional shortening (26.84±3.87, p=0.05), end-diastolic volume (81.77±27.5 vs 87.8, p=0.02), and LV end-systolic volume (baseline 43.18±14.7 vs 47.15, p=0.05). Other parameters, such as " interventricular septum, deceleration time (DT), E'E' lateral wall, and WMSI (1.45±0.45 vs. 1.41±0.25, p=0.05), also showed significant changes from baseline to follow-up. Conversely, no significant differences were found in LV EF, mitral inflow velocities, or tissue Doppler velocities. There was a notable increase in global LV strain during follow-up compared to baseline (11.74 vs. 16.7±3.49, p<0.005), along with a significant rise in late diastolic strain rate from baseline to follow-up (0.96 vs. 1.45±0.78, p<0.005). However, other strain parameters for both RV and LV did not demonstrate significant changes. Among the 158 patients who experienced acute

myocardial infarction and underwent primary PCI, 7 encountered MACE during the one-month follow-up. This included 5 fatalities, 2 cases of pulmonary oedema, and several repeat hospital admissions for similar symptoms. One of the two patients who experienced cardiac arrest during their hospital stay unfortunately passed away. Additionally, 2 patients were readmitted due to ischemic chest pain. No occurrences of stroke, stent restenosis, or recurrent myocardial infarction were reported. Worsening systolic function was observed in 2 patients, while 5 patients experienced a decline in diastolic function—two patients presented with LV apical thrombus. Adverse outcomes and the corresponding echocardiographic changes after one month. When comparing echocardiographic and strain parameters between the two groups (those who experienced MACE versus those who did not), it was found that end-systolic volume was significantly higher in the MACE group at one-month follow-up compared to the event-free group (48.62±27.11 vs 41.87±16.4, p=0.05). WMSI was also elevated in patients with adverse events compared to those without (1.91±0.46 vs. 1.36±0.04, p=0.00). Furthermore, global LV strain was lower in patients who faced MACE than in the event-free cohort (8.75±2.3 vs. 14.5±3.46, p=0.05). ROC analysis demonstrated that a cut-off value of left ventricular ejection fraction (LV EF) less than 45% yields a sensitivity of 84% and a specificity of 14% in predicting major adverse cardiac events (MACE), with an area under the curve (AUC) of 0.26 and a p-value of 0.05. Additionally, a multivariable binary logistic regression analysis identified LV EF as an independent predictor of MACE at the one-month follow-up, with an odds ratio (OR) of 0.89 (95% confidence interval [CI] 0.78-0.976, p = 0.05). Further analysis revealed that a cut-off value of the wall motion score index (WMSI) greater than 1.36 is predictive of MACE, demonstrating a sensitivity of 94% and a specificity of 58% (AUC 0.77, p = 0.05). Multivariable binary logistic regression also indicated that LV EF is an independent predictor of death at one-month follow-up, with an OR of 0.86 (95% CI 0.781-0.975, p = 0.05).

DISCUSSION

This study aimed to conduct a longitudinal evaluation of left ventricular (LV) systolic function across three subgroups of culprit vessels. The findings indicate that LV strain can provide important prognostic information regarding subclinical LV dysfunction and remodelling progression. Notably, an improvement in deformation function was observed one month after revascularization, regardless of the affected vessel. The clinical significance of LV ejection fraction (EF) and wall motion score index (WMSI) in predicting major adverse cardiac events (MACE) was emphasized. A significant reduction in LV strain was noted among patients who experienced MACE compared to those who remained event-free, along with a marked increase in LV end-systolic volume (ESV) and WMSI values in the MACE group. The current research demonstrated a notable improvement in global LV strain one month post-revascularization, surpassing conventional systolic function parameters such as LVEF, thus establishing it as a superior predictor of systolic function. Differences in the recovery of myocardial function were also observed based on the specific target vessel undergoing revascularization. Specifically, this study found that when the left anterior descending (LAD) artery was the culprit's vessel, global longitudinal strain (GLS) was significantly more impaired, corroborating findings from H. Ben Slima et al. [6] However, improvements in LV systolic function were noted across all culprit vessels post-revascularization. In contrast to findings by Swati Mahajan et al., which indicated an improvement in GLS primarily with non-LAD vessel revascularization, variations in myocardial function recovery could be attributed to the different territories supplied by these arteries, impacting the extent of stunned myocardium present in each area [7]. Additionally, LV function deterioration and MACE incidence were more prevalent in patients with LAD as the culprit vessel, aligning with Cong et al.'s observations that MACE was more frequent in patients with anterior wall myocardial infarction (MI) [8]. The current analysis found that LV strain did not reliably predict MACE at one month post-procedure. However, notable differences in clinical and echocardiographic variables were observed when comparing patients with and without events. LV strain was significantly lower in the MACE group than those without events, highlighting GLS's greater sensitivity in detecting subclinical LV dysfunction relative to LVEF. Other studies supported the idea that, in addition to NT-pro BNP and LVEF, parameters like peak systolic longitudinal strain (PSLS) can be good predictors of adverse outcomes within 30 days [9]. The present research demonstrated that

when LV GLS was analyzed alongside routinely used measures such as LVEF or WMSI in multivariable binary logistic regression, both LVEF and WMSI exhibited superior predictive capabilities compared to strain. MACE was identified in 4.4% of acute MI patients following successful percutaneous coronary intervention (PCI), with higher rates documented in patients with anterior wall MI compared to those with other vessel occlusions, reinforcing Cong et al.'s findings [10].LV remodelling describes the changes in left ventricular end-diastolic volume (LVEDV) and/or LV ESV over time, beginning with a cardiac event and extending into a follow-up period. Abnormal LV regeneration can lead to adverse outcomes, including heart failure and arrhythmias, from a pathophysiological standpoint [11]. Identifying individuals at high risk for adverse remodelling post-infarction within the acute phase is critical. Techniques such as echocardiography and GLS derived from speckle tracking can facilitate earlier detection of regional and global myocardial dysfunction through a more objective assessment. The present study identified significant LV EDV and ESV elevations from baseline to one-month follow-up, suggesting LV remodelling, and highlighted that patients with MACE had notably increased LV ESV compared to the event-free group. These findings align with research by Wael Tawfik MD et al. in 2020. Additionally, the study found that WMSI values exceeding 1 were prevalent in the MACE group at one month, compared with event-free individuals, substantiating previous evidence that a WMSI score of 1.3 predicts increased LV dilatation after acute MI. The findings indicated that a WMSI value greater than 1.3 had a sensitivity of 94% and a specificity of 58% (p-value = 0.05) for predicting MACE, akin to results documented by Saad and colleagues. Due to time constraints, the complete proposed sample size was not achieved, and the study was confined to a one-month follow-up period; as such, both MACE and adverse remodelling—given their delayed occurrence—should be investigated in future studies with extended follow-up durations. The study did not incorporate additional strain parameters, such as post-systolic shortening, radial strain, and circumferential strain, which could provide further insights [12-14].

CONCLUSION

In conclusion, global left ventricular (LV) strain accurately indicates systolic function more than left ventricular ejection fraction (LVEF). Among patients with acute myocardial infarction (MI) who underwent successful percutaneous coronary intervention (PCI), major adverse cardiac events (MACE) were observed in 4.4% of cases. The initial measurements of LV ejection fraction and wall motion score index (WMSI) emerged as promising, practical, and independent predictors of major adverse cardiac events at a one-month follow-up, surpassing the predictive capability of LV strain. Our findings indicate that while LV strain is associated with subclinical LV dysfunction and remodelling, it does not predict major adverse cardiac events.

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