Section: Cardiology

Original Research Article

PREDICTORS OF MYOCARDIAL FUNCTIONAL RECOVERY AFTER SUCCESSFUL REPERFUSION IN ACUTE ST-ELEVATION MYOCARDIAL INFARCTION: A COMPARATIVE STUDY OF THROMBOLYSIS AND PRIMARY PCI USING SPECKLE TRACKING ECHOCARDIOGRAPHY.

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ABSTRACT

Background: Speckle tracking echocardiography (STE) is a non-invasive imaging technique used to assess myocardial function, offering insights into cardiac deformation and remodeling. This study aims to identify predictors of myocardial functional recovery following successful reperfusion of acute ST-elevation myocardial infarction (STEMI), using STE to assess functional recovery markers such as global longitudinal strain (GLS), ejection fraction (EF), and left ventricular (LV) remodeling.

Materials and Methods: A total of 80 STEMI patients were randomized into two groups: 40 patients received thrombolysis, and 40 underwent primary PCI. Patients were monitored for post-reperfusion myocardial recovery using STE to measure EF, GLS, mitral annular plane systolic excursion (MAPSE), and LV internal diameters at both end-systole and end-diastole at baseline and at 3-month follow-up. Univariate and multivariate regression analyses were performed to identify significant predictors of myocardial recovery.

Results: Primary PCI significantly improved myocardial functional recovery compared to thrombolysis, with a notable increase in EF (53.84% vs. 48.20%) and GLS (-19.54% vs. -14.85%) at 3 months. Additionally, LV internal diameter at end-diastole and MAPSE were identified as important predictors of functional recovery. Early post-reperfusion EF and MAPSE were found to be strongly associated with long-term myocardial recovery.

Conclusion: This study demonstrates that early post-reperfusion markers, such as EF, GLS, and LV remodeling, are crucial predictors of myocardial functional recovery after STEMI. Primary PCI was associated with better long-term functional outcomes compared to thrombolysis, emphasizing the importance of early and efficient reperfusion strategies. Speckle tracking echocardiography proves to be an essential tool in evaluating myocardial recovery, potentially guiding clinical decision-making in STEMI management.

Keywords: STEMI, Speckle Tracking Echocardiography, Myocardial Recovery, Functional Recovery, Ejection Fraction, Global Longitudinal Strain, Left Ventricular Remodeling, Primary PCI, Thrombolysis.

INTRODUCTION

Myocardial functional recovery following reperfusion in acute ST-elevation myocardial infarction (STEMI) is a critical determinant of long-term patient outcomes. Rapid reperfusion, typically achieved through percutaneous coronary intervention (PCI), is essential for salvaging ischemic myocardium and preventing irreversible damage. However, despite successful reperfusion, the degree of myocardial recovery is heterogeneous and influenced by multiple factors. Speckle tracking echocardiography (STE), a non-invasive imaging technique that assesses myocardial strain, has emerged as a valuable tool in evaluating myocardial function after reperfusion. STE quantifies myocardial deformation in real-time, providing insights into both regional and global ventricular performance, even before conventional systolic dysfunction becomes apparent. Unlike traditional echocardiographic methods, STE is sensitive to subtle changes in myocardial tissue, offering a unique perspective on myocardial injury and recovery, especially in the acute phase following reperfusion.[1,2]

Several factors, both clinical and procedural, have been identified as predictors of myocardial recovery after successful reperfusion in STEMI. The time from symptom onset to reperfusion, often referred to as door-to-balloon time (DTB), is a well-established predictor of myocardial salvage. Earlier reperfusion is associated with reduced infarct size and better functional recovery, whereas delays in reperfusion can exacerbate myocardial injury, leading to poorer outcomes.[3] Additionally, the presence of microvascular obstruction (MVO) after reperfusion has been shown to significantly affect myocardial recovery. MVO, detected via imaging techniques like magnetic resonance imaging (MRI) or STE, correlates with impaired functional recovery and poor long-term prognosis.[4] Studies have demonstrated that baseline myocardial strain, measured by STE at the time of reperfusion, can predict functional recovery, with lower strain values often correlating with more extensive myocardial damage and poorer prognosis.[5,6]

Moreover, systemic inflammation has gained recognition as an important factor influencing myocardial recovery. Elevated inflammatory markers, such as C-reactive protein (CRP) and interleukin-6 (IL-6), have been associated with adverse remodeling and impaired recovery following STEMI.[7] The role of collateral circulation, which can mitigate ischemic injury in regions distant from the infarct zone, has also been highlighted in several studies. Enhanced collateral circulation has been associated with improved functional recovery, as it preserves myocardial tissue perfusion during ischemic events.[8]

This study aims to identify key predictors of myocardial functional recovery following reperfusion in acute ST-elevation myocardial infarction using speckle tracking echocardiography, focusing on clinical, procedural, and imaging-derived factors.

MATERIALS AND METHODS

This observational study was conducted to identify predictors of myocardial functional recovery following reperfusion in patients with acute ST-elevation myocardial infarction (STEMI) using speckle tracking echocardiography. The study was carried out at the Department of Cardiology, Kamineni Academy of Medical Sciences and Research Centre, LB Nagar, Hyderabad, over a period of one year, from January 2024 to December 2024. A total of 80 patients who underwent successful reperfusion via percutaneous coronary intervention (PCI) or via thrombolysis were included. Patients were selected based on the following **Inclusion Criteria:** age between 18 and 80 years, STEMI diagnosis confirmed by clinical symptoms, ECG findings, and elevated cardiac biomarkers, and successful reperfusion within 12 hours. Exclusion criteria included chronic heart failure, prior myocardial infarction, significant arrhythmias, or contraindications to echocardiography.

Upon admission, demographic details, clinical history, and baseline characteristics (e.g., hypertension, diabetes, smoking) were recorded. Echocardiographic assessments were performed within 24 hours of reperfusion using a GE Vivid E95 ultrasound machine, which is known for its advanced speckle tracking capabilities. Standard echocardiographic views, including the parasternal long axis, apical four-chamber, and two-chamber views, were obtained to assess left ventricular (LV) dimensions, ejection fraction, and regional myocardial strain. Speckle tracking echocardiography was used to evaluate longitudinal strain, focusing on both the infarct-related territory and remote myocardium. This technique provides a sensitive measurement of myocardial deformation, allowing for detailed analysis of functional recovery at the segmental level.

The primary outcome was the recovery of myocardial function, measured by follow-up echocardiography after 3 months. Global and regional strain parameters were re-assessed to determine changes in myocardial function. Statistical analysis was performed to identify significant correlations between these factors and the extent of myocardial functional recovery.

Ethical approval was obtained from the institutional review board at Department of Cardiology, Kamineni Academy of Medical Sciences and Research Centre, LB Nagar, Hyderabad, and informed consent was secured from all participants.

RESULTS

In this study, 80 patients were equally divided into two groups, one receiving thrombolysis and the other undergoing primary PCI. The demographic characteristics and clinical risk factors such as age, gender, comorbidities, and lifestyle habits were comparable between the two groups, with no significant differences found (P-values > 0.05).

Table 1: Demographic characteristics, risk factors distribution, and type of myocardial infarction at presentation

Parameter		Thrombolysis (n=40)	Primary PCI (n=40)	P value
Mean Age (years)		**59.83± 7.98 years**	**60.2 ± 11.02 years**	**0.643**
Gender	Males	30 (75%)	28 (70%)	0.598
	Females	10 (25%)	12 (30%)	
Comorbidities	Diabetes Mellitus	23 (57.5%)	26 (65%)	0.802
	Hypertension (HTN)	20 (50%)	25 (62.5%)	0.530
	Dyslipidemia	30 (75%)	33 (82.5%)	0.924
Positive family history of CAD		10 (25%)	11 (27.5%)	0.893
Lifestyle habits	Smoking history	25 (62.5%)	23 (57.5%	0.745
	Alcohol	26 (65%)	24 (60%)	0.654

Table 2 highlights the distribution of STEMI locations, showing no significant differences between the thrombolysis and primary PCI groups (P > 0.05). However, significant differences were found in treatment-related times. The thrombolysis group had a shorter average time from symptom onset to presentation (57.02 ± 10.4 minutes) compared to primary PCI (74.02 ± 23.4 minutes, P = 0.032), indicating quicker hospital presentation. Additionally, the time between door to perfusion was significantly shorter for thrombolysis (15.2 ± 10.4 minutes) versus primary PCI (23.4 ± 15.2 minutes, P = 0.014), suggesting faster administration of thrombolytic therapy.

Table 2: Presentation of STEMI

Parameter		Thrombolysis (n=40)	Primary PCI (n=40)	P value
Location of STEMI	Anterior wall	25 (62.5%)	26 (65%)	0.262
	Antero- lateral/ lateral wall	5 (12.5%)	8 (20%)	0.657
	Inferior wall	10 (25%)	6 (15%)	0.954
Average time between onset of symptoms to presentation (in minutes)		57.02 ± 10.4 min	74.02 ± 23.4 min	0.032
Average time between door to perfusion (in minutes)		15.2 ± 10.4min	23.4 ± 15.2 min	0.014

In terms of functional recovery post-reperfusion, there was a notable difference in the ejection fraction (EF) after three months. While the thrombolysis group showed a modest improvement in EF (48.20%), the primary PCI group exhibited a more significant recovery (53.84%), indicating a potentially superior long-term benefit in myocardial function with primary PCI. Similarly, global longitudinal strain (GLS), a measure of myocardial deformation, was more favorable in the PCI group both post-reperfusion and after three months, suggesting better myocardial recovery and less long-term damage. Furthermore, while both groups experienced a reduction in LV internal diameter at end-diastole and systole, the primary PCI group demonstrated a more favorable reduction, particularly in end-systolic diameter, which could reflect improved ventricular remodeling and function.

Table 3: Ejection fraction and global longitudinal strain post-reperfusion and after 3 months

Parameter		Thrombolysis (n=40)	Primary PCI (n=40)	P value
Ejection Fraction (%)	Post Reperfusion	47.02 ± 7.10	46.80 ± 7.84	0.0052
	After 3 months	48.20 ± 6.99	53.84 ± 11.20	
Global Longitudinal Strain (%)	Post Reperfusion	-14.32 ± 2.54	-14.28 ± 2.47	0.0021
	After 3 months	-14.85 ± 4.58	-19.54 ± 4.2	
Mitral annular plane systolic excursion (cm/sec)	Post Reperfusion	10.25 ± 0.4	10.95 ± 0.9	
	After 3 months	11.78 ± 1.4	12.34 ± 1.74	
LV internal diameter at end diastolic (cm)	Post Reperfusion	5.1 ± 2.4	5.07 ± 1.27	0.954
	After 3 months	4.25 ± 0.74	4.05 ± 0.4	
LV internal diameter at end systole (cm)	Post Reperfusion	5.25 ± 0.7	5.3 ± 0.8	0.0345
	After 3 months	4.55 ± 1.2	4.02 ± 0.9	

Table 4 shows univariate and multivariate regression analysis results for predicting factors at 3-month follow-up. In univariate analysis, post-reperfusion ejection fraction (EF), mitral annular plane systolic excursion (MAPSE), and LV internal diameters were significant. Multivariate analysis identified EF, MAPSE, and LV internal diameter at end-diastole as key predictors of long-term recovery.

Table 4: Univariate and multivariate regression analysis for predicting factors (at 3 months of follow –up)

Parameter	Univariate analysis (p value)	Multivariate analysis
Post reperfusion Ejection fraction	<0.001	0.0063
Time between duration of symptoms to presentation	0.0023	0.145
Door to perfusion time	0.007	0.214
Mitral annular plane systolic excursion (cm/sec)	<0.001	<0.001
LV internal diameter at end systole (cm)	<0.001	0.254
LV internal diameter at end diastolic (cm)	<0.0001	0.0124

DISCUSSIONS

This study aimed to compare the efficacy of thrombolysis and primary percutaneous coronary intervention (PCI) in patients with ST-elevation myocardial infarction (STEMI), focusing on functional recovery markers such as ejection fraction (EF), global longitudinal strain (GLS), and left ventricular (LV) remodeling at 3 months post-reperfusion. The study's results underscore the clinical relevance of timely intervention and its impact on myocardial recovery, exploring not only the immediate reperfusion time but also long-term cardiac function and structural changes.

The findings of this study echo those of previous research examining the outcomes of thrombolysis versus PCI in STEMI. Several studies, including those by Smith et al,[9] have reported that PCI, when performed early, tends to yield better outcomes in terms of myocardial function and survival compared to thrombolysis. Smith et al,[9] found a similar pattern of superior EF and reduced infarct size with PCI at 6 months post-reperfusion. However, this study contributes by providing more comprehensive data on functional recovery, including measures like GLS and LV remodeling, and by offering a detailed comparison of both early and long-term outcomes. The present study’s finding of a more substantial recovery in EF and GLS in the primary PCI group aligns with those of Nalluri et al,[10] who also reported that PCI significantly improved myocardial recovery compared to thrombolysis after STEMI.

Notably, the time between symptom onset and presentation, as well as door-to-perfusion times, were significantly shorter in the thrombolysis group, which was expected given the procedural differences between thrombolysis and PCI. However, as indicated by previous studies, the quick reperfusion achieved with thrombolysis does not appear to fully compensate for the enhanced myocardial recovery seen with PCI. These findings are consistent with those of Gersh et al,[11] who concluded that despite quicker intervention, thrombolysis is less effective in improving long-term functional outcomes than PCI, especially in patients presenting within an early time window. In addition, Zhang et al,[12] found that despite shorter time delays with thrombolysis, PCI showed a significant reduction in adverse cardiac events and better long-term myocardial function.

Moreover, in multivariate analysis, this study identified EF, mitral annular plane systolic excursion (MAPSE), and LV internal diameter at end-diastole as the key predictors of long-term recovery, a finding corroborated by similar research, such as that by Kumar et al,[13] which highlighted MAPSE as an important predictor of cardiac recovery in STEMI patients. The fact that LV remodeling was more favorable in the PCI group, particularly with respect to end-diastolic diameter, points to better ventricular function and structural recovery after PCI, supporting earlier findings by Zhang et al,[12] and Kumar et al.[13]

CONCLUSION

This study identifies key predictors of myocardial functional recovery in acute ST-elevation myocardial infarction (STEMI) patients following successful reperfusion. Speckle tracking echocardiography revealed that early post-reperfusion ejection fraction, mitral annular plane systolic excursion, and left ventricular remodeling (particularly LV internal diameter at end-diastole) were significant predictors of long-term recovery. Primary PCI led to better myocardial recovery compared to thrombolysis, reinforcing the importance of early and efficient reperfusion in STEMI management. These findings highlight the utility of speckle tracking echocardiography as a valuable tool for monitoring myocardial recovery and guiding treatment strategies in STEMI patients.

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Conflicts of Interest: None declared.

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