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ORIGINAL RESEARCH

EARLY ECHOCARDIOGRAPHIC CHANGES IN LEFT VENTRICULAR FUNCTION FOLLOWING PERCUTANEOUS TRANSLUMINAL CORONARY ANGIOPLASTY FOR ANTERIOR WALL MYOCARDIAL INFARCTION

Vishva Rajpuria[1], **Shaifali Vainsh**[2], **Tirth Modi**[3], **Avi Shah**[4*]

[1] *Assistant Professor, Department of General Medicine, Smt. NHL Medical College, Ahmedabad, Gujarat, Gujarat, India*

[2] *Senior Resident, Department of General Medicine, Shri M. P. Shah Medical College, Jamnagar,, Gujarat, India*

[3] *Senior Resident, Department of General Medicine, Baroda Medical College, Vadodara,, Gujarat, India*

[4] *Resident, Department of Medical Oncology, Geetanjali Medical College and Hospital (GMCH), Udaipur, Rajasthan, India*

*Correspondence: Avi Shah <avibshah@gmail.com>

ABSTRACT

Background: Timely restoration of epicardial coronary flow after anterior wall myocardial infarction is expected to limit infarct size and preserve left ventricular function, but the echocardiographic changes occurring in the first few days after isolated left anterior descending artery revascularisation are less well described. We assessed early changes in left ventricular systolic and diastolic function after percutaneous transluminal coronary angioplasty and compared patients reperfused within and beyond 12 hours of symptom onset. **Methods:** In this prospective observational study, 50 consecutive adults with acute anterior wall ST-segment elevation myocardial infarction underwent successful angioplasty of an isolated left anterior descending lesion. Transthoracic echocardiography was performed within 24 hours before the procedure and repeated on the third day. Paired comparisons were made for the whole cohort and separately for early (≤12 h) and late (>12 h) presenters. **Results:** Left ventricular ejection fraction rose from 39.08 ± 11.19% to 44.29 ± 8.81% ($p = 0.004$), accompanied by a reduction in end-systolic diameter from 39.20 ± 6.51 to 36.25 ± 5.50 mm ($p = 0.004$), whereas the reduction in end-diastolic diameter from 50.95 ± 5.20 to 49.09 ± 5.43 mm was not statistically significant ($p = 0.092$). Peak early (E) and late (A) transmitral velocities both increased ($p < 0.001$), whereas the E/A ratio showed no significant change, from 0.994 ± 0.59 to 0.96 ± 0.52 ($p = 0.484$). E/e′ decreased from 11.28 ± 5.22 to 9.49 ± 3.69 ($p = 0.029$). Although some parameters showed numerically different magnitudes of change between early and late presenters, none of the between-group differences was statistically significant. **Conclusions:** Successful angioplasty of an isolated left anterior descending lesion was followed by improvement in systolic function and by changes in diastolic filling within three days. Early echocardiographic recovery was observed in both groups, with no statistically significant difference in the magnitude of change between early and late presenters.

Keywords: Anterior wall myocardial infarction; Percutaneous coronary intervention; Echocardiography; Left ventricular dysfunction; Myocardial reperfusion

INTRODUCTION

Acute myocardial infarction remains one of the largest single contributors to death and disability worldwide, notwithstanding sustained progress in primary prevention, antithrombotic pharmacotherapy and reperfusion strategy [1]. Anterior wall myocardial infarction arises most often from occlusion of the left anterior descending coronary artery, which perfuses a larger share of left ventricular myocardium than any other epicardial vessel. Infarction in this territory is accordingly associated with greater loss of contractile tissue, more pronounced ventricular dilatation and worse clinical outcomes than infarction elsewhere, particularly when reperfusion is delayed [2,3].

Primary percutaneous coronary intervention, performed within an appropriate time window, is the preferred reperfusion strategy in ST-segment elevation myocardial infarction. Early restoration of epicardial flow limits infarct size, preserves viable myocardium, attenuates adverse remodelling and improves survival. Because the quantity of myocardium salvaged governs long-term outcome, contemporary international guidance places considerable emphasis on shortening total

ischaemic time [3]. What is less clear is how quickly, and in what pattern, ventricular function begins to recover once flow has been restored, and whether that early trajectory differs between patients treated promptly and those treated late.

Transthoracic echocardiography is the most accessible non-invasive means of following ventricular structure and function after infarction. Left ventricular ejection fraction and chamber dimensions describe systolic performance and the degree of acute dilatation [4], while transmitral inflow velocities and tissue Doppler indices of mitral annular motion provide an estimate of filling pressure and carry independent prognostic weight [5]. Several series have documented recovery of systolic function after primary percutaneous coronary intervention, including in patients revascularised late [6,7], and longer ischaemic times have been linked to poorer recovery and to higher estimated filling pressures after reperfusion [8,9]. Data describing the immediate post-procedural echocardiographic profile after revascularisation of an isolated left anterior descending lesion, however, remain sparse, and the influence of reperfusion timing on that early profile has rarely been examined directly.

We therefore set out to characterise echocardiographic indices of left ventricular systolic and diastolic function before and three days after isolated left anterior descending angioplasty in patients with acute anterior wall myocardial infarction, and to compare early functional recovery between those reperfused within 12 hours of symptom onset and those reperfused later.

METHODOLOGY

Study design and setting

This prospective observational study was conducted between February 2021 and July 2022 in the Cardiac Care Unit of a tertiary care teaching hospital in Udaipur, Rajasthan, India. The study protocol was approved by the Human Research Ethics Committee (HREC) of Geetanjali Medical College & Hospital, Udaipur (Ref. GU/HREC/EC/2021/1877), before recruitment began, and written informed consent was obtained from every participant or, where appropriate, from a legal representative. The study was conducted in accordance with the Declaration of Helsinki. Reporting follows the STROBE recommendations for observational research.

Participants

Consecutive patients aged 18 years or older admitted with acute anterior wall ST-segment elevation myocardial infarction, and who underwent successful primary percutaneous transluminal coronary angioplasty of an isolated left anterior descending artery lesion, were eligible for inclusion.

Exclusion criteria: Patients were excluded if they had non-ST-segment elevation myocardial infarction, previous myocardial infarction, thrombolysis for the index event, previous coronary artery bypass grafting, angiographically significant multivessel disease, atrial fibrillation, haemodynamically significant valvular disease, congenital heart disease or known cardiomyopathy. These criteria were applied so that the observed echocardiographic changes could be attributed as far as possible to revascularisation of a single territory.

Exposure and outcomes

The exposure of interest was the interval between symptom onset and restoration of coronary flow. Participants were classified a priori into an early reperfusion group (≤12 hours) and a late reperfusion group (>12 hours), a threshold chosen because it corresponds to the conventional limit for routine primary percutaneous coronary intervention in stable patients. The primary outcome was the change in echocardiographic indices between the pre-procedural and third-day studies. Systolic function was assessed using left ventricular ejection fraction (LVEF), left ventricular end-diastolic diameter (LVEDD), and left ventricular end-systolic diameter (LVESD). Diastolic function was assessed using peak early (E) and late (A) transmitral filling velocities, the E/A ratio, and the ratio of peak early transmitral velocity to early diastolic mitral annular velocity (E/e′).

Sample size

Fifty consecutive eligible patients were enrolled. The sample size was determined by the number of eligible patients presenting during the predefined recruitment period rather than by a formal power calculation, and the study should therefore be regarded as exploratory with respect to the subgroup comparisons.

Percutaneous coronary intervention

All patients underwent coronary angiography followed by angioplasty using standard interventional technique. Radial or femoral access was used according to operator preference. After identification of the culprit left anterior descending lesion, balloon predilatation was performed where required and a drug-eluting stent was deployed. Procedural success was defined as stent deployment with residual stenosis below 30% and restoration of Thrombolysis in Myocardial Infarction grade 3 flow [10]. Guideline-directed antiplatelet therapy, anticoagulation and adjunctive medical treatment were administered according to institutional protocol.

Echocardiography

Comprehensive transthoracic echocardiography was performed within 24 hours before angioplasty and repeated three days afterwards using a Vivid S5 system (GE Healthcare, Wauwatosa, WI, USA) with a 1–3 MHz phased-array transducer. All measurements were obtained by a single experienced echocardiographer using the same imaging protocol. Ejection fraction was calculated by the modified biplane Simpson method from apical two- and four-chamber views, and chamber dimensions were obtained in accordance with the recommendations of the American Society of Echocardiography and the European Association of Cardiovascular Imaging [4]. Transmitral inflow was interrogated by pulsed-wave Doppler at the leaflet tips to derive peak E and A velocities and the E/A ratio. Early diastolic mitral annular velocity (e′) was measured by tissue Doppler imaging, and E/e′ was used as a non-invasive estimate of left ventricular filling pressure [5].

Data collection

Demographic details, clinical presentation, angiographic and procedural findings and echocardiographic measurements were recorded prospectively on a standardised data collection form. Hypertension and diabetes mellitus were defined by current use of antihypertensive or antidiabetic medication, or by fulfilment of accepted diagnostic criteria at the index admission.

Minimisation of bias

Measurement bias was addressed by using a fixed imaging protocol and a single experienced echocardiographer for all studies. Procedural variability was limited by adherence to institutional protocols for intervention and for post-procedural medical therapy. Selection bias was reduced by consecutive enrolment of all eligible admissions during the study period.

Statistical analysis

Data were entered into Microsoft Excel and analysed with IBM SPSS Statistics version 27.0 (IBM Corp., Armonk, NY, USA). Continuous variables are presented as mean ± standard deviation and categorical variables as counts with percentages. The E/A ratio was calculated for each individual patient and the resulting individual ratios were then averaged for reporting. Pre- and post-procedural measurements were compared using the paired Student t test. Between-group comparisons of early and late presenters used the independent-samples t test for continuous variables and the chi-square or Fisher exact test for categorical variables; the magnitude of change in each echocardiographic index was compared between groups by applying the independent-samples t test to the within-patient difference scores. All tests were two-tailed and a p value below 0.05 was taken as statistically significant. No adjustment was made for multiple comparisons, and the subgroup analyses should be interpreted accordingly. Every enrolled participant completed both scheduled echocardiographic studies and no data were missing for any variable entering the analysis.

RESULTS

Baseline characteristics

Fifty patients with acute anterior wall myocardial infarction were enrolled, of whom 33 (66.0%) were reperfused within 12 hours of symptom onset and 17 (34.0%) after 12 hours. Diabetes mellitus was the commonest comorbidity, present in 36 patients (72.0%), followed by hypertension in 32 (64.0%) and dyslipidaemia in 21 (42.0%). Chronic obstructive pulmonary disease was recorded in 16 patients (32.0%) and hypothyroidism in 15 (30.0%). A family history of coronary artery disease was the least frequently reported risk factor, present in 14 patients (28.0%).

Baseline clinical characteristics are presented in Table 1. The mean age was 54.82 ± 12.03 years among early presenters and 59.82 ± 8.49 years among late presenters, with no statistically significant difference (p = 0.133). The mean symptom onset-to-presentation interval was significantly shorter among early presenters than late presenters (6.76 ± 2.82 vs. 18.29 ± 3.44 hours, p < 0.001). Chest pain was more frequently reported among early presenters than late presenters (93.9% vs. 47.1%, p < 0.001), while palpitation and shortness of breath did not differ significantly between the groups.

Table 1. Baseline clinical characteristics of early and late presenters

Category	Parameter	Early presenters (n=33)	Late presenters (n=17)	P-value
Age (years)	Mean ± SD	54.82 ± 12.03	59.82 ± 8.49	0.133
Symptom onset to presentation (hours)	Mean ± SD	6.76 ± 2.82	18.29 ± 3.44	<0.001
	Male	26 (78.8%)	11 (64.7%)	
Chest pain, n (%)	No	2 (6.1%)	9 (52.9%)	<0.001
	Yes	31 (93.9%)	8 (47.1%)	
Palpitation, n (%)	No	15 (45.5%)	9 (52.9%)	0.616
	Yes	18 (54.5%)	8 (47.1%)	
Gabhrahat, n (%)	No	10 (30.3%)	16 (94.1%)	<0.001
	Yes	23 (69.7%)	1 (5.9%)	
Shortness of breath, n (%)	No	21 (63.6%)	10 (58.8%)	0.74
	Yes	12 (36.4%)	7 (41.2%)	
Hypertension, n (%)	No	16 (48.5%)	2 (11.8%)	0.013
	Yes	17 (51.5%)	15 (88.2%)	
Diabetes mellitus, n (%)	No	12 (36.4%)	2 (11.8%)	0.099
	Yes	21 (63.6%)	15 (88.2%)	
Hypothyroidism, n (%)	No	22 (66.7%)	13 (76.5%)	0.474
	Yes	11 (33.3%)	4 (23.5%)	
Dyslipidemia, n (%)	No	16 (48.5%)	13 (76.5%)	0.075
	Yes	17 (51.5%)	4 (23.5%)	
COPD, n (%)	No	25 (75.8%)	9 (52.9%)	0.101
	Yes	8 (24.2%)	8 (47.1%)	
Family history of CAD, n (%)	No	20 (60.6%)	16 (94.1%)	0.018
	Yes	13 (39.4%)	1 (5.9%)	
Smoking, n (%)	No	17 (51.5%)	7 (41.2%)	0.488
	Yes	16 (48.5%)	10 (58.8%)	
Alcohol use, n (%)	No	16 (48.5%)	12 (70.6%)	0.136
	Yes	17 (51.5%)	5 (29.4%)	

Hypertension was more frequent among late presenters than early presenters (88.2% vs. 51.5%, p = 0.013), whereas diabetes mellitus did not differ significantly between groups (88.2% vs. 63.6%, p = 0.099). Family history of coronary artery disease was more frequent among early presenters (39.4% vs. 5.9%, p = 0.018). No statistically significant between-group differences were observed for hypothyroidism, dyslipidemia, COPD, smoking, or alcohol use (Table 1).

Echocardiographic change in the whole cohort

The systolic function of the left ventricle was enhanced within the three-day period after the angioplasty. The mean ejection fraction increased from 39.08 ± 11.19% to 44.29 ± 8.81% (p = 0.004), and the mean end-systolic diameter decreased significantly from 39.20 ± 6.51 mm to 36.25 ± 5.50 mm (p = 0.004), whereas the end-diastolic diameter decreased from 50.95 ± 5.20 mm to 49.09 ± 5.43 mm without reaching statistical significance (p = 0.092). Diastolic indices also changed. Peak early and late transmitral filling velocities both increased significantly (both p < 0.001), whereas the mean E/A ratio changed from 0.994 ± 0.59 to 0.96 ± 0.52 without reaching statistical significance (p = 0.484). The E/E′ ratio decreased from 11.28 ± 5.22 to 9.49 ± 3.69 (p = 0.029) (Table 2).

Table 2. Echocardiographic parameters before and three days after percutaneous transluminal coronary angioplasty

Variable	Pre-intervention Mean ± SD	Post-intervention Mean ± SD	Mean Difference	P-value
LVESD (mm)	39.20 ± 6.51	36.25 ± 5.50	2.96	0.004
LVEDD (mm)	50.95 ± 5.20	49.09 ± 5.43	1.86	0.092
LVEF (%)	39.08 ± 11.19	44.29 ± 8.81	−5.21	0.004
E (cm/s)	61.72 ± 20.61	71.13 ± 23.36	−9.40	<0.001
A (cm/s)	70.14 ± 15.22	81.62 ± 16.31	−11.48	<0.001
E/A ratio	0.994 ± 0.59	0.96 ± 0.52	0.03	0.484
E/E′	11.28 ± 5.22	9.49 ± 3.69	1.78	0.029

Data presented as mean±SD, LVEDD, left ventricular end-diastolic diameter; LVEF, left ventricular ejection fraction; LVESD, left ventricular end-systolic diameter; PTCA, percutaneous transluminal coronary angioplasty; SD, standard deviation. Paired Student t test.

Early presenters

Among the 33 patients reperfused within 12 hours, end-systolic diameter fell from 36.79 ± 6.19 mm to 33.78 ± 5.07 mm (p = 0.038), whereas the changes in end-diastolic diameter and ejection fraction did not reach statistical significance (p = 0.382 and p = 0.098, respectively). Peak E and peak A velocities both increased significantly (p = 0.007 and p < 0.001, respectively), whereas the E/A ratio changed from 0.63 ± 0.17 to 0.62 ± 0.14 without statistical significance (p = 0.802). E/E′ decreased from 9.14 ± 4.64 to 7.56 ± 2.80, although this change was not statistically significant (p = 0.155) (Table 3).

Table 3. Echocardiographic parameters before and after angioplasty in early presenters reperfused within 12 hours (n = 33)

Parameter	Pre-PTCA, Mean ± SD	Post-PTCA, Mean ± SD	Mean Difference	P-value
LVESD (mm)	36.79 ± 6.19	33.78 ± 5.07	3.01	0.038
LVEDD (mm)	49.84 ± 4.48	48.75 ± 6.02	1.09	0.382
LVEF (%)	42.26 ± 12.39	46.51 ± 9.58	−4.25	0.098
E (cm/s)	48.69 ± 9.91	56.62 ± 11.83	−7.92	0.007
A (cm/s)	78.34 ± 8.95	91.28 ± 9.36	−12.93	<0.001
E/A ratio	0.63 ± 0.17	0.62 ± 0.14	0.009	0.802
E/E′	9.14 ± 4.64	7.56 ± 2.80	1.58	0.155

Data presented as mean±SD, LVEDD, left ventricular end-diastolic diameter; LVEF, left ventricular ejection fraction; LVESD, left ventricular end-systolic diameter; PTCA, percutaneous transluminal coronary angioplasty; SD, standard deviation. Paired Student t test.

Late presenters

Among the 17 patients reperfused after 12 hours, end-systolic diameter and ejection fraction improved significantly, whereas the reduction in end-diastolic diameter did not reach statistical significance (p = 0.132). Peak E and peak A velocities increased significantly (p = 0.001 and p = 0.008, respectively). The E/A ratio changed from 1.69 ± 0.47 to 1.61 ± 0.31, without reaching statistical significance (p = 0.520), whereas E/E′ decreased significantly from 15.41 ± 3.57 to 13.24 ± 1.82 (p = 0.048) (Table 4).

Table 4. Echocardiographic parameters before and after angioplasty in late presenters reperfused after 12 hours

Parameter	Pre-PTCA, Mean ± SD	Post-PTCA, Mean ± SD	Mean Difference	P-value
LVESD (mm)	43.90 ± 4.18	41.04 ± 2.09	2.86	0.025
LVEDD (mm)	53.11 ± 5.92	49.77 ± 4.16	3.34	0.132
LVEF (%)	32.91 ± 3.88	39.97 ± 4.90	−7.06	<0.001
E (cm/s)	87.02 ± 8.61	99.29 ± 10.66	−12.28	0.001
A (cm/s)	54.22 ± 11.87	62.89 ± 8.59	−8.66	0.008
E/A ratio	1.69 ± 0.47	1.61 ± 0.31	0.083	0.520
E/E′	15.41 ± 3.57	13.24 ± 1.82	2.17	0.048

Data presented as mean±SD, LVEDD, left ventricular end-diastolic diameter; LVEF, left ventricular ejection fraction; LVESD, left ventricular end-systolic diameter; PTCA, percutaneous transluminal coronary angioplasty; SD, standard deviation. Paired Student t test.

Comparison of change between groups

The magnitude of change did not differ significantly between early and late presenters for any echocardiographic parameter (Table 5). Although late presenters showed numerically greater changes in LVEDD, LVEF, E and E/E′, while early presenters showed numerically greater changes in LVESD and A, none of these between-group differences reached statistical significance (all p > 0.05). The E/A ratio also showed no significant difference in the magnitude of change between early and late presenters (0.009 ± 0.21 vs. 0.083 ± 0.52; p = 0.581). These unadjusted subgroup comparisons were not corrected for multiple testing or for differences in baseline severity.

Table 5. Magnitude of change in echocardiographic parameters after angioplasty, early versus late presenters

Variable	Early presenters (n=33), Mean ± SD	Late presenters (n=17), Mean ± SD	P-value
LVESD (mm)	3.01 ± 7.97	2.86 ± 4.76	0.946
LVEDD (mm)	1.09 ± 7.06	3.34 ± 8.68	0.328
LVEF (%)	−4.25 ± 14.33	−7.06 ± 5.90	0.445
E (cm/s)	−7.92 ± 15.78	−12.28 ± 13.14	0.334
A (cm/s)	−12.93 ± 13.44	−8.66 ± 11.89	0.275
E/A ratio	0.009 ± 0.21	0.083 ± 0.52	0.581
E/E′	1.58 ± 6.25	2.17 ± 4.18	0.73

Independent-samples t test applied to within-patient difference scores.

DISCUSSION

In this prospective series of 50 patients undergoing isolated left anterior descending angioplasty for acute anterior wall ST-segment elevation myocardial infarction, three observations stand out. First, left ventricular systolic function improved measurably within three days of successful revascularisation, with a higher ejection fraction and a smaller end-systolic diameter, while end-diastolic diameter showed a nonsignificant reduction. Second, diastolic filling indices showed selective changes over the same interval, with higher transmitral velocities and a lower E/e′ ratio, whereas the E/A ratio did not change significantly in the cohort as a whole. Third, although the magnitude of change was numerically different for

several echocardiographic parameters between the two reperfusion groups, none of the between-group comparisons reached statistical significance.

Baseline characteristics also differed between the two reperfusion groups. Late presenters had a significantly longer symptom onset-to-presentation interval and were more frequently hypertensive, whereas chest pain and a family history of coronary artery disease were more common among early presenters. These differences indicate that the two groups were not completely comparable at baseline and may have contributed to differences in their clinical presentation and echocardiographic profiles. Despite these baseline differences, the magnitude of change in echocardiographic parameters did not differ significantly between early and late presenters. These findings do not provide evidence of a statistically significant difference in early echocardiographic recovery according to reperfusion timing, although the small subgroup sizes and baseline differences warrant cautious interpretation.

Systolic function

The rise in ejection fraction from 39.08 ± 11.19% to 44.29 ± 8.81% ($p = 0.004$) is of a magnitude consistent with what has been reported over longer follow-up. In a prospective study of 188 patients undergoing primary percutaneous coronary intervention, mean ejection fraction improved from 39.79 ± 6.2% at baseline to 44.90 ± 5.47% at three months ($p < 0.001$), with a significant fall in end-diastolic diameter by six months [6]. That a comparable increment was already apparent at three days in our cohort suggests that measurable functional recovery may occur early, before longer-term ventricular remodelling is complete. Early comprehensive echocardiography after primary percutaneous coronary intervention has been shown to identify patients most likely to recover ventricular function, which supports imaging soon after revascularisation rather than deferring assessment to discharge or later [11].

The reduction in end-systolic diameter, together with the nonsignificant reduction in end-diastolic diameter, is consistent with attenuation of the acute chamber dilatation that follows a large ischaemic insult [2]. Mechanistically, restoration of epicardial flow allows recovery of myocardium that is stunned but viable, improving regional contractility and hence global systolic performance. The extent and speed of that recovery depend on infarct size, the duration of ischaemia and the integrity of the microcirculation [2]. The three-day improvement we observed is compatible with partial resolution of stunning, with further gain likely over the subsequent weeks. Attar and colleagues found ejection fraction after primary percutaneous coronary intervention to be higher than after rescue, facilitated or deferred intervention, which is consistent with the view that earlier restoration of flow favours functional recovery [12].

Diastolic function

Diastolic indices showed selective changes over the same three days. Both peak transmitral velocities increased significantly, while E/e′ decreased significantly from 11.28 ± 5.22 to 9.49 ± 3.69. In contrast, the E/A ratio changed only minimally, from 0.994 ± 0.59 to 0.96 ± 0.52, and the difference was not statistically significant ($p = 0.484$). These findings should be interpreted together rather than as evidence of uniform normalisation of diastolic function. Transmitral flow reflects the interaction of myocardial relaxation, filling pressure and chamber compliance in the acute post-infarction period, and no single index resolves these contributions. The fall in E/e′, in the absence of a significant change in the E/A ratio, may indicate an early reduction in estimated left ventricular filling pressure without demonstrable normalisation of transmitral filling patterns. Invasive pressure–volume measurements made during primary percutaneous coronary intervention have shown that indices of relaxation begin to improve within minutes of reperfusion, providing a plausible physiological basis for early changes in diastolic function [13].

Our findings sit alongside earlier work linking ischaemic duration to diastolic behaviour after reperfusion. In 95 consecutive patients studied by echocardiography three days after primary percutaneous coronary intervention, Prasad and colleagues found symptom-to-reperfusion time and infarct size to be independent predictors of a restrictive filling pattern, which in turn predicted adverse events at 12 months [8]. Shacham and colleagues studied 180 patients with first ST-segment elevation myocardial infarction and reported higher E/septal e′ (13.3 ± 5.0 versus 9.7 ± 2.3) and E/lateral e′ (13.4 ± 5.1 versus 9.7 ± 2.4) in those reperfused beyond 185 minutes, with time to reperfusion remaining independently associated with E/e′ on multivariable analysis; the effect was most marked in anterior infarction, the very group

represented in our cohort [9]. The fall in E/e′ that we observed after angioplasty is therefore consistent with an early reduction in estimated filling pressure once the left anterior descending territory is reperfused.

E/e′ is endorsed by the American Society of Echocardiography and European Association of Cardiovascular Imaging as a non-invasive surrogate for left ventricular filling pressure [5], and its trajectory carries prognostic information. Miyake and colleagues showed that a higher E/e′ at discharge after successful primary percutaneous coronary intervention was independently associated with worse long-term outcome, and that a fall in E/e′ over time tracked improvement in diastolic function and predicted subsequent events [14]. A measurable early decline in E/e′ is thus of more than descriptive interest.

Early versus late reperfusion

The comparison between the two reperfusion groups did not demonstrate statistically significant differences in the magnitude of change for any echocardiographic parameter. Late presenters showed numerically greater changes in LVEDD, LVEF, peak E velocity, E/A ratio and E/E′, whereas early presenters showed a numerically greater change in peak A velocity and LVESD; however, none of these between-group comparisons reached statistical significance. These findings therefore suggest broadly comparable early echocardiographic recovery between the two reperfusion groups rather than a demonstrably different pattern of recovery.

Late presenters had lower baseline ejection fraction than early presenters (32.91 ± 3.88% versus 42.26 ± 12.39%), which may have contributed to the numerically greater change observed in the late-presenter group. However, the between-group difference in the magnitude of ejection fraction change was not statistically significant (−7.06 ± 5.90% versus −4.25 ± 14.33%; p = 0.445).

Longer ischaemic times are consistently associated with poorer functional recovery when baseline severity is taken into account. Seo and colleagues, studying 151 patients with ST-segment elevation myocardial infarction, identified total ischaemic time as an independent predictor of recovery of regional wall motion, with reperfusion within 180 minutes conferring significantly greater improvement [15]. A large Korean nationwide registry likewise showed that patients presenting 12 hours or more after symptom onset had lower baseline ejection fraction and were less likely to undergo primary percutaneous coronary intervention than early presenters [16]. Our findings are therefore compatible with the possibility of early functional recovery even among patients reperfused late, although they do not demonstrate that late reperfusion provides equivalent or superior recovery.

Although early presenters showed a numerically greater change in LVESD, while late presenters showed a numerically greater change in the E/A ratio, neither between-group difference was statistically significant. Therefore, the present findings do not provide evidence that early reperfusion was associated with a significantly different pattern of early echocardiographic recovery compared with later reperfusion. Prasad and colleagues found the relationship between symptom-to-reperfusion time and severe diastolic dysfunction to be independent of other clinical and angiographic variables [8], and Subramaniyan and colleagues, following 61 patients with first anterior wall ST-segment elevation myocardial infarction after primary angioplasty of the left anterior descending artery, reported progressive improvement in diastolic indices over six months, with both the timing and the effectiveness of reperfusion influencing the degree of recovery [17]. Taken together with our own results, these findings describe a ventricle that is changing on several axes at once during the first days after reperfusion, and argue for interpreting systolic and diastolic indices jointly rather than in isolation.

Clinical implications

Three practical points follow. First, meaningful changes in both systolic and selected diastolic indices are detectable as early as the third day after successful left anterior descending angioplasty, so an echocardiogram obtained before discharge provides usable information rather than merely a baseline for later comparison. Second, because E/e′ changes early and carries prognostic weight [5,14], tissue Doppler assessment deserves a routine place in the post-procedural study in anterior infarction and not only in patients with overt heart failure. Third, the significant within-group improvements observed in several echocardiographic parameters among patients revascularised beyond 12 hours indicate that late

presenters may still exhibit early functional recovery; however, this study was not designed to determine whether the timing of revascularisation independently influenced that recovery [3,7].

CONCLUSION

Successful percutaneous transluminal coronary angioplasty of an isolated left anterior descending lesion in acute anterior wall myocardial infarction was followed by echocardiographic change detectable within three days. Systolic function improved, with a higher ejection fraction and smaller end-systolic diameter, while end-diastolic diameter showed a nonsignificant reduction. Diastolic filling indices also showed selective changes, with increases in transmitral E and A velocities and a reduction in E/e′, while the E/A ratio did not change significantly. No statistically significant difference was observed in the magnitude of early echocardiographic change between patients reperfused within and beyond 12 hours of symptom onset. Larger multicentre studies with serial imaging and clinical follow-up are needed to establish whether these early changes predict sustained improvement in ventricular remodelling and better long-term outcome.

Declarations

Ethics approval and consent to participate: The study protocol was approved by the Human Research Ethics Committee (HREC) of Geetanjali Medical College & Hospital, Udaipur (Ref. GU/HREC/EC/2021/1877), and written informed consent was obtained from all participants.

Conflict of interest: The authors declare that they have no competing interests.

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Data availability: The dataset analysed during the current study is available from the corresponding author on reasonable request.

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