Original Article

A Study of Left Ventricular Global Longitudinal Strain in ST-segment Elevation Myocardial Infarction after Extended Pharmaco-invasive Therapy

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Background : The efficacy of primary Percutaneous Coronary Intervention (PCI) as well as Pharmaco-invasive strategy for revascularization in ST-Elevation Myocardial Infarction (STEMI) patients has been well proven. But in developing countries most of the patients are unable to undergo Angiography/PCI within first 24 hours of presentation. In such patients studies assessing the efficacy of revascularization through extended Pharmaco-invasive therapy (fibrinolysis followed by elective PCI between >24 hours to 2 weeks of fibrinolytic administration) are sparse.

Aims and Objectives : To observe change in Left Ventricle (LV) function as assessed by Global Longitudinal Strain (GLS) at 3 months and at 6 months in cohort of STEMI patients undergoing extended Pharmaco-invasive therapy.

Materials and Mehods : This is a prospective observational study conducted in SCB Medical college, Cuttack. 65 patients who presented with STEMI were included in the study from November, 2020-2021. All the patients underwent thrombolysis with various fibrinolytic agents followed by elective PCI within 24 hours to 2 weeks. LV function was assessed through Echocardiography (Simpson's Biplane and GLS) at preprocedure, 3 months and at 6 months.

Results : Mean age of the sample population was 60.18±8.289 years. All of the patients were thrombolysed within a mean window period of 7.57±2.744 hours. The mean time to revascularization was 69.35±22.97 hours after thrombolysis. The mean GLS were -11.5±3.3, -13.2±4.9 and -15.1±3.1 at pre-procedure, at 3 months follow-up and at 6 months follow-up respectively. When change in mean GLS at 6 months from baseline was compared with respect to the time to PCI, mean change in GLS at 6 months was found to have strong linear correlation with time to PCI after thrombolysis (r=0.773, p24 hours) still outcomes are better in those in whom PCI was done early ie, within 48 hours (by -4.50) than those in whom PCI was done after 96 hours (by -2.63) of Thrombolysis.

Conclusion : Extended Pharmaco-invasive strategy is a reasonable option if PCI cannot be performed within the first 24 hours. This strategy is thus likely to widen the window between Thrombolysis and PCI. There is a significant improvement of LV function as assessed by GLS at short-term follow-up of 6 months.

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Key words **: LV GLS, STEMI, Pharmaco-invasive Strategy.**

Timely re-perfusion in patients presenting with ST-Elevation Myocardial Infarction (STEMI) leads to myocardial salvage and improvement in Left Ventricle (LV) function. The preferred means for reperfusion in STEMI is primary Percutaneous Coronary Intervention (PCI) within 24 hours of symptom onset, provided, it can be performed within 120 minutes of first medical contact[1]. But unfortunately, in developing countries like India a large subset of patients reach PCI capable centres only after 24 hours of the onset of chest pain. These subsets of patients may potentially benefit from revascularization. Studies assessing the efficacy of extended Pharmaco-invasive therapy (fibrinolysis followed by elective PCI after 24 hours) are sparse. The current study postulates that extended Pharmaco-invasive therapy is a reasonable option for STEMI patients presenting late to a PCI capable centre.

To assess the LV function in such patients we would utilize various echocardiographic parameters such as Ejection Fraction by Simpson's biplane method, end diastolic volume, end systolic volume, stroke volume and Global longitudinal strain through Speckle

Editor's Comment :

- There is significant improvement in LV function as assessed by GLS and LVEF, in patients undergoing extended Pharmaco-invasive therapy in whom primary pci within 24 hours was not possible. However GLS serves as a better tool for LV assessment as compared to LVEF especially in patients with post MI.

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tracking[2]. Strain is a sensitive tool that correlates well with other measures of cardiac function, and detect changes in myocardial contractility, both normal and abnormal, across a wide range of ischemic syndromes[3].

Material and Method

This prospective observational study was conducted in the Department of Cardiology, SCB Medical College and Hospital, Cuttack from November, 2020-2021. In 65 patients were included in the study.

Inclusion criteria :

The patients included in the study were those who fulfilled the criteria of ST Elevation Myocardial Infarction as established by The American College of Cardiology, American Heart Association, European Society of Cardiology, and the World Heart Federation committee and presented within a window period of 12 hours from the onset of chest pain.

Exclusion criteria :

- AMI patients who already have coronary stent implanted for any indication.
- Patients who had previous episodes of MI.
- Left main or multi-vessel coronary artery disease mandating coronary artery bypass graft.
- Patients who do not wish to follow up at 6 months.
- Patients with cardiogenic shock.
- Renal failure
- Mechanical complications

All patients received fibrinolytic therapy and then underwent PCI in accordance with the current standard of practice. The minimum time to PCI was 24 hours while the maximum time to PCI was 2 weeks after the completion of Thrombolysis. PCI was defined as successful when Thrombolysis in MI (TIMI) flow grade was 2/3 post procedure and less than 20% residual stenosis.

All patients underwent 2D-TTE before coronary angiogram and PCI. The LV ejection fraction was assessed by Simpson's biplane method, and GLS was estimated by speckle-tracking echocardiography. The following Echocardiographic parameters were also analysed: End Diastolic Volume, End Systolic Volume, Stroke Volume, Mitral Regurgitation.

All patients were followed-up at 3 months and at 6 months after discharge. A repeat 2D-TTE assessing all the above-mentioned parameters was performed at 3 months and at 6 months.

The collected data were analysed using the Statistical Package for the Social Sciences (IBM SPSS for Windows version 23.0). Categorical variables were presented as frequency and percentage while continuous variables were described as mean value ± standard deviation. Paired t-test was used to compare values at baseline, 3months and at 6 months. Pearson's correlation was used to establish statistical difference between groups. $P<0.05$ was considered to indicate statistically significant difference.

Observations

In 65 patients who fulfilled the inclusion criteria were included in the study. The mean age of the patients was 60.18 ± 8.3 years. 60% of patients were Male while rest 40% of patients were Female. In 39 patients were Diabetic, 30 patients were Hypertensive while 25 patients were smoker. 32 patients had no risk factors or a single risk factor. 33 patients had two or more risk factors. Mean window period for Thrombolysis was 7.57±2.7 hours. STREPTOKINASE was used in 35 patients (53.85%) for Thrombolysis while TENECTEPLASE and RETEPLASE each was used in 15 patients (23.08 %) for thrombolysis. The mean time to revascularization was 69.35± 22.98 hours after Thrombolysis. In 34 (52.31%) patients PCI was done in single vessel; in 26 (40%) PCI was done in 2 vessels, while in 5 (7.69%) of patients PCI was done in 3 vessels. In Multivessel PCI all vessels were addressed in the same setting.

The mean LV ejection fraction were 46.54±8.8%, 47.9±8.6% and 51.12±7.6% at preprocedural, at 3 months follow-up and at 6 months follow-up respectively. The mean increase in Left Ventricular Ejection Fraction (LVEF) was 1.3% at 3 months follow up and 4.6% at 6 months follow-up. The mean Global Longitudinal Strain (GLS) were -11.5±3.3, -13.2±4.9 and -15.1±3.1 at preprocedural, at 3 months follow-up and at 6 months follow-up respectively. The mean increase in GLS was -1.66 at 3 months follow up and -3.6 at 6 months follow-up from baseline.

Paired T-test was used to correlate LVEF and GLS at baseline, at 3 months and at 6 months. The correlation was found to be significant at p-value of less than 0.01.

Mean Left Ventricular End-Diastolic Volume (LV EDV) were 83.6±12.1 ml, 86.42±10.8 ml and 88.12±9.9 ml at preprocedural, at 3 months follow-up and at 6 months follow-up respectively. Mean Left Ventricular End Systolic Volume (LVESV) were 44.3±9.4 ml, 44.91±9.9 ml and 42.8±8.4 ml at preprocedural, at 3 months follow-up and at 6 months follow-up respectively. Mean LV SV were 39±9.7 ml, 41.4±8.9 ml and 44.6±7.9 ml at preprocedural, at 3 months follow-up and at 6 months follow-up respectively.

Paired T-test was used to correlate these values at baseline, 3 months and at 6 months follow-up. EDV and SV were found to increase linearly with time following intervention which was found to be significant with p-value <0.01. ESV was found to decrease at 6 months with a significant p-value <0.05 which may be due to more increase in SV than the simultaneous lesser increase in EDV, suggesting improvement in LV function.

When the mean change in GLS at 3 months and at 6 months follow up from baseline was correlated with respect to the number of risk factors present, a significant moderate linear correlation (r=0.513 at 6 months, p<0.01) was found inferring better improvement in GLS in patients with no risk factors or 1 risk factor (by -2.91, -2.64 at 3 months and -4.92, -4.28 at 6 months) than those with all 2 or 3 risk factors (by -1.78, -0.69 at 3 months and -2.85, -1.53 at 6 months).

When the mean change in LVEF at 6 months follow up was compared with that from baseline with respect to the number of risk factors, a low correlation (r=0.35 at 6 months, p=0.015) was found, inferring better improvement in LVEF in patients with no risk factors (by 5.20%) as compared to those with 2 or 3 risk factors (by 3.88% and 1.57% respectively). No significant difference in change in mean LVEF was found at 3 months follow up when compared with that at baseline with respect to the number of risk factors.

When change in mean GLS at 6 months with that at baseline was compared with respect to the time to intervention (PCI), mean change in GLS at 6 months was found to have strong linear correlation with time to PCI after thrombolysis (r=0.773, p<0.01) inferring that though delayed (>24 hours.) still outcomes are better in those in whom PCI was done early ie, within 48 hours. (by -4.50) than those in whom PCI was done after 96 hours (by -2.63) of thrombolysis. There was no significant difference noted at 3 months follow up in GLS.

When change in mean LVEF at 3 months and 6 months follow up was compared with that at baseline with respect to time to intervention, no significant difference was found; though LVEF improved more in whom the PCI was done within 48 hours. (by 5.42%) than in those whom PCI was done after 96 hours (by 3.68%) (Tables 1-4).

Table 1 — *Comparison of LVEF and GLS at Baseline, 3 Months and 6 Months*

Variable	Pre-procedure	3 Months	6 Months	P-value
LVEF	46.54±8.8	47.88±8.6	51.12±7.6	<0.01
GLS	-11.53±3.3	-13.2±4.86	-15.05±3.1	<0.01

Table 2 — *Comparison of Echo Parameters at Baseline, at 3 Months and at 6 Months*

Variable	Pre-procedure	3 Months	P-value	6 Months	P-value
EDV	83.6±12.1	86.42±10.8	<0.01	88.12±9.9	<0.01
ESV	44.29±9.4	44.91±9.9	0.227	42.77±8.3	<0.05
SV	39±9.69	41.35±8.9	<0.01	44.60±7.9	<0.01

Table 3 — *Comparison of GLS and LVEF with Number of Risk Factors*

	Risk Factors	Mean	STD	Pearson Coefficient	P-value
Mean GLS3-GLS baseline	0	-2.91	9.71	0.313	<0.01
	1	-2.64	1.85		
	2	-1.78	1.76		
	3	-0.69	1.19		
Mean GLS6-GLS baseline	0	-4.92	2.46	0.513	<0.01
	1	-4.28	1.90		
	2	-2.85	1.50		
	3	-1.53	0.96		
Mean LVEF3-LVEF baseline	0	2.70	2.26	-0.038	0.12
	1	0.54	2.33		
	2	1.91	2.34		
	3	0.57	1.51		
Mean LVEF6-LVEF baseline	0	5.20	4.29	-0.350	0.015
	1	6.09	3.46		
	2	3.88	3.88		
	3	1.57	3.05		

Table 4 — *Comparison of GLS and LVEF with Time to PCI after Thrombolysis*

	Time To PCI	Mean	STD	Pearson Coefficient	P-value
Mean GLS3-GLS baseline	≤48 hours	-1.66	6.70	0.151	0.230
	49-95 hours	-1.87	1.78		
	≥96 hours	-1.36	1.63		
Mean GLS6-GLS baseline	≤48 hours	-4.50	1.99	0.733	<0.01
	49-95 hours.	-3.25	2.15		
	≥96 hours	-2.63	1.35		
Mean LVEF3-LVEF baseline	≤48 hours	1.05	2.42	-0.001	0.993
	49-95 hours	1.08	2.30		
	≥96 hours	2.12	2.34		
Mean LVEF 6-LVEF baseline	≤48 hours	5.42	2.21	-0.272	0.08
	49-95 hours	4.47	4.09		
	≥96 hours	3.68	4.61		

Discussion

In developing countries and remote areas of many developed countries, Pharmaco-invasive strategy is now the most commonly used approach in the management of patients presenting with STEMI because despite all efforts, there are many patients who reach PCI capable centers >24 hours after Thrombolysis. The current study clearly demonstrates the fate of such patients with respect to their LV function as assessed by Echocardiography.

This study shows that there is significant increase

in both LVEF and GLS both at short term follow up of 3 months and at 6 months duration. LV EDV and SV were found to increase linearly with time following intervention. ESV was found to decrease at 6 months which may be due to more increase in SV than the simultaneous lesser increase in EDV, suggesting improvement in LV function. Also, the increase in mean LVEDV at 6 months from baseline was 5.4%, this is well below 20% increase in LVEDV, as seen in patients with post MI LVAR (Left Ventricular Adverse Remodeling) which is an independent factor leading to Heart Failure[4].

A significant moderate linear correlation was found when mean change in GLS was compared with the number of risk factors present both at 3 months and at 6 months follow up, inferring better improvement in GLS after revascularization in patients with no risk factors than in those with all 2 or 3 risk factors. Such correlation was found only at 6 months with LVEF. The lesser improvement may be due to sub-clinical myocardial disease process in patients with multiple risk factors where Global Longitudinal Strain measurements appeared to be sensitive indicators for sub-clinical diseases as compared to LVEF[5].

When correlated with time to intervention after PCI this study also clearly shows that the improvement in post-PCI LV function, as assessed through GLS, are better in those in whom PCI was done early (ie, <48 hours in this study) than in those whom PCI is still delayed (ie, >96 hours). Such a change could not be detected through LVEF. Thus, the assessment of LV function after PCI in patients with STEMI was superior with GLS when compared to 2D LVEF. As strain imaging is an inexpensive tool, it can be applied easily to assess LV function in the large subset of population (Figs 1A, 1B & 2).

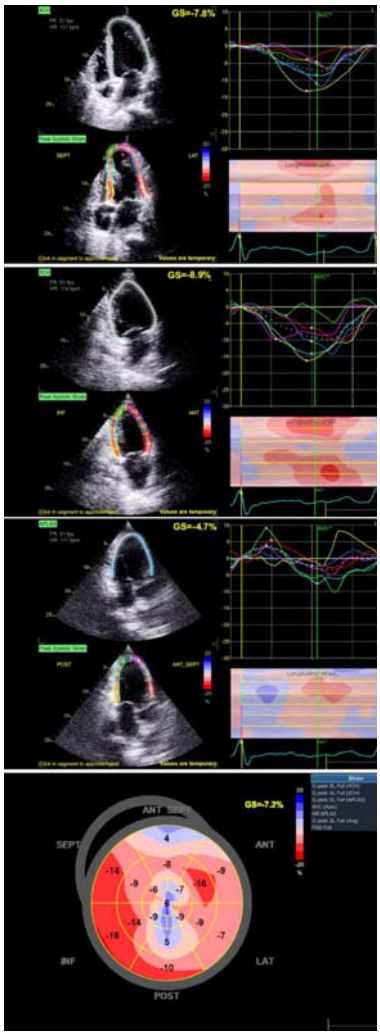

Fig 1A — GLS of a patient with anterior wall STEMI at baseline

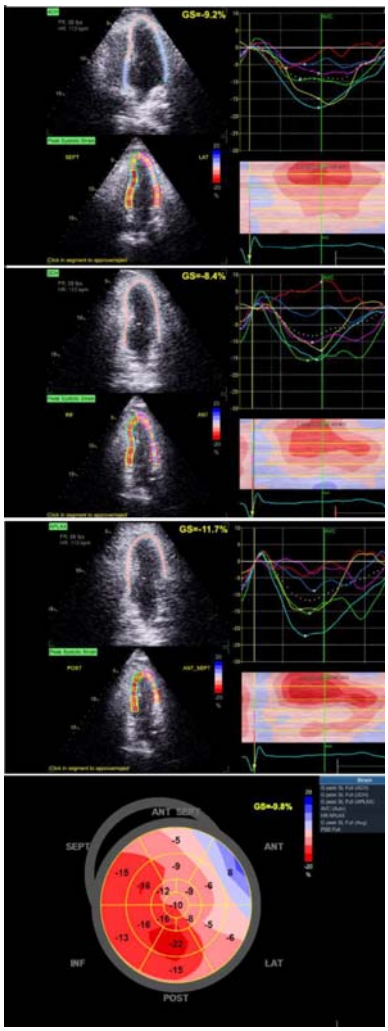

Fig 1B — GLS of the same patient at 6 months

Conclusion

The following conclusions can be drawn from the study:

- Extended Pharmaco-invasive strategy is a reasonable option if PCI cannot be performed within the first 24 hours. This

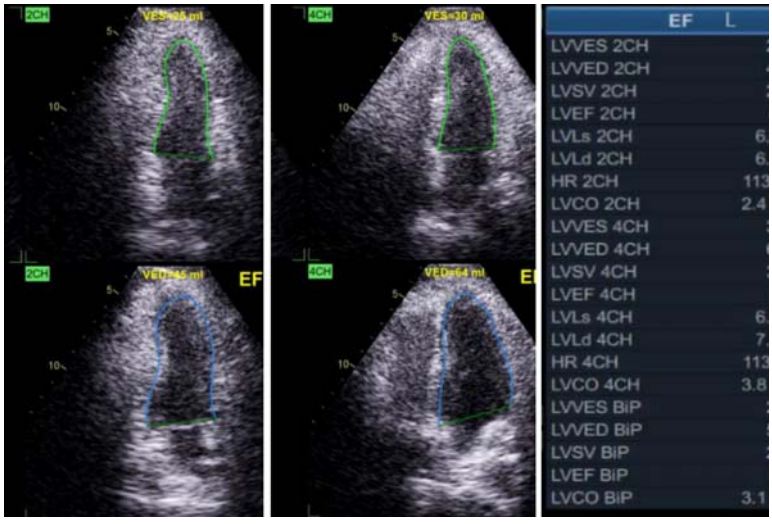

Fig 2 — Simpson's Biplane Method of Measuring LV Ejection Fraction

strategy is thus likely to widen the window between Thrombolysis and PCI and broaden the subset of patients eligible for coronary angiogram plus revascularization after Thrombolysis.

- There is a significant improvement of LV function as assessed by TTE when measured through GLS and with ejection fraction at short-term follow-up of 6 months.
- Improvement in LV function was significantly more in patients with no or single risk factor as compared to those with 2 or more risk factors as assessed by GLS and LVEF at 6 months follow-up.
- GLS is a better tool for LV assessment as compared to 2D LVEF especially in post-MI patients.

References

1 Mamas MA, Anderson SG, O'Kane PD — Impact of left ventricular function in relation to procedural outcomes following percutaneous coronary intervention: insights from the British Cardiovascular Intervention Society. *Eur Heart J*. 2014; **35:** 3004-12.

2 Mistry N, Beitnes JO, Halvorsen S — Assessment of left ventricular function in ST-elevation myocardial infarction by global longitudinal strain: a comparison with ejection fraction, infarct size, and wall motion score index measured by non-invasive imaging modalities. *Eur J Echocardiograph*. 2011; **12:** 678-83.

3 Mistry N, Beitnes JO, Halvorsen S — Assessment of left ventricular function in ST-elevation myocardial infarction by global longitudinal strain: a comparison with ejection fraction, infarct size, and wall motion score index measured by non-invasive imaging modalities. *Eur J Echocardiograph*. 2011; **12:** 678-83

4 Bolognese L, Neskovic AN, Parodi G, Cerisano G, Buonamici P, Santoro GM, *et al* — Left ventricular remodeling after primary coronary angioplasty: patterns of left ventricular dilation and long-term prognostic implications. *Circulation* 2002; **106(18):** 2351-7.

5 Yu CM, Sanderson JE, Marwick TH, Oh JK — Tissue Doppler imaging a new prognosticator for cardiovascular diseases. *J Am Coll Cardiol* 2007; **20(3):** 234-43.