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Original Article

Frequency of Left Ventricular Function Decline in Patients Undergoing Primary Percutaneous Coronary Intervention (PCI) for St Segment Elevation Myocardial Infarction (STEMI)

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ABSTRACT

Objective: To determine the frequency of left ventricular function decline in patients undergoing primary PCI for STEMI.
Study Design: Prospective longitudinal study.
Place and Duration of Study: Department of Cardiology, Punjab Institute of Cardiology, Lahore Pakistan, from Dec 2024 to Jun 2025.
Methodology: This study was done after taking ethical approval from IRB of Punjab Institute of Cardiology, Lahore. This study was done on 66 patients diagnosed with acute STEMI undergoing primary PCI after taking informed consent. Data collection was done using pre-designed proforma. >5% decrease in ejection fraction as compared to pre PCI at follow up (48 hours post PCI and 4 weeks) was defined as decline in LV function. Data analysis was performed using SPSS version 26, with *p*-value <0.05 considered significant.
Results: LV function decline was observed in 28.8% participants, with significantly higher frequency was observed in those who presented late and had multiple vessel disease *p*= 0.047 and 0.001, respectively. The LVEF before PCI (53.27±3.67%), after PCI (52.10±3.91%), and at four weeks follow-up (51.66±4.32%), indicating gradual decline in LVEF over time.
Conclusion: This study highlights that significant proportion of patient's experience decline in left ventricular function following primary PCI for STEMI. The findings underscore the critical impact of delayed presentation and presence of multivessel coronary artery disease on post-procedural LV performance. These results emphasize the importance of early intervention and comprehensive assessment of coronary anatomy to optimize long-term cardiac function and outcomes in STEMI patients undergoing PCI.

Keywords: Left Ventricular Function, Primary PCI, STEMI.

How to Cite This Article: *Din SJ, Ahmad S, Arif A, Cheema SA, Danish FA, Taha M. Frequency of Left Ventricular Function Decline in Patients Undergoing Primary Percutaneous Coronary Intervention (PCI) for St Segment Elevation Myocardial Infarction (STEMI). Pak Armed Forces Med J 2025; 75(Suppl-7): S1167-S1171. DOI: https://doi.org/10.51253/pafmj.v75iSUPPL-7.13611*

INTRODUCTION

STEMI is life-threatening cardiovascular emergency, characterized by persistent ST-segment elevation on ECG, typical chest pain, and raised cardiac biomarkers.[1] Globally, IHD remains the leading cause of mortality, accounting for over 9 million deaths in 2019 alone.[2] In Pakistan, IHD prevalence found to be 17%, with STEMI being major contributor.[3] Its common risk factors includes diabetes, hypertension, dyslipidemia, smoking, and family history.[4]

In recent years, significant advancements in early reperfusion strategies including primary PCI along with antithrombotic therapy, have led to marked reduction in mortality associated with STEMI.[5] Consequently, international guidelines now recommend primary PCI as standard of care for STEMI patients.[6]

Despite these advances, STEMI continues to impose substantial global health burden. Large-scale registry data demonstrate improved short- and long-term survival rates with widespread adoption of reperfusion therapies, especially primary PCI, which plays critical role in minimizing infarct size and preserving left ventricular systolic function.[7] However, not all patients benefit equally from revascularization. Studies report that 4.7% to 8.6% patients may experience decline in LV function even after successful PCI.[8] Development of post-PCI congestive heart failure also significantly contributes to morbidity.[9] Ma *et al.*, have shown that patients with impaired LV ejection fraction following PCI have substantially higher mortality at 30 days, one year, and beyond, compared to those with preserved LV function.[10] These findings emphasize the need for continuous evaluation of LV function even after successful PCI.

While primary PCI effectively restores coronary blood flow and reduces myocardial injury in STEMI patients, subset remains at risk for progressive LV dysfunction. Therefore, early identification and monitoring of patients at risk, along with optimized

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Received: 28 Jun 2025; revision received: 14 Oct 2025; accepted: 15 Oct 2025

pharmacologic and supportive care, are essential for improving long-term outcomes. In context of this, the present study was conducted to evaluate the burden of LV function decline among STEMI patients undergoing primary PCI in our local setting.

METHODOLOGY

After obtaining ethical approval from Institutional Review Board of Punjab Institute of Cardiology, Lahore (Ref: RTPGME-Research-324, dated: 02-12-2024), this prospective longitudinal study was conducted at Department of Cardiology, Punjab Institute of Cardiology Lahore, Pakistan from 15 December 2024 to 15 June 2025.

This study was conducted on 66 patients fulfilling the selection criteria.

Inclusion Criteria: Patients of either gender, aged 25–60 years, diagnosed with acute STEMI (ST segment elevation >1 mm in two contiguous limb leads and 2 mm in precordial leads or new-onset LBBB) who presented within 12 hours of symptom onset and underwent primary PCI were included.

Exclusion Criteria: Patients were excluded if they presented with Killip class III or IV, had pre-PCI LVEF <45%, or had chronic kidney disease (serum creatinine >1.6 mg/dL), chronic liver disease (cirrhosis on ultrasound or hepatitis B/C positive), chronic obstructive pulmonary disease, were pregnant or alcoholic, or had previous history of MI, PCI, or coronary artery bypass grafting.

A sample size of 66 patients was calculated using WHO sample size calculator, based on 95% confidence level, 10% absolute precision, and expected frequency of decline in LV function among STEMI patients treated with PCI as 22%[11]. Patients were enrolled through non-probability convenient sampling.

All enrolled patients underwent thorough clinical assessment. Demographic data including name, age, gender, and time of presentation following symptom onset (<6 hours or 6–12 hours) was recorded. Risk factors such as diabetes mellitus, hypertension, dyslipidemia, smoking status, and family history of ischemic heart disease were noted. All patients had baseline investigations including complete blood count, renal function tests, cardiac enzymes, and serial ECGs. Baseline transthoracic echocardiography was done to measure LVEF prior to PCI. All patients underwent primary PCI performed by cardiologist team with minimum of four years' experience. Details of PCI procedure including culprit artery (LAD, RCA, LCX, left main, or multivessel involvement) and achievement of reperfusion (defined as TIMI grade 3 flow) were documented.[12]

Post-procedure, all patients remained admitted in coronary care unit for 24 hours. Repeat transthoracic echocardiography was done at 48 hours post-PCI, and subsequently at 4 weeks follow-up to evaluate changes in LV function. Echocardiography was conducted by single cardiologist. A decline in LVEF was defined as >5% decrease in LV ejection fraction as compared to pre PCI at 48 hours or 4 weeks follow up. Patients who expired or lost to follow up during the study period were excluded from final analysis. All patients received standard discharge medication including dual antiplatelet therapy, statins, beta blockers, ACE inhibitors, diuretics (if required), along with individualized risk factor control, dietary modification, smoking cessation, and glycemic control. The principal investigator was responsible for record maintenance. Data was collected using structured proforma and entered manually.

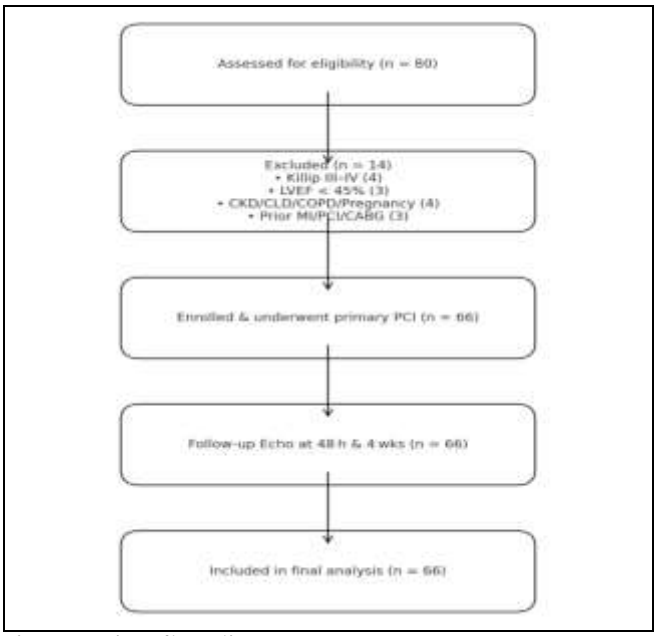

Figure: Patient flow diagram

Data analysis was performed using Statistical Package for the Social Sciences version 26. Quantitative variables like age and LVEF were presented as mean and standard deviation. Qualitative variables like gender, risk factors, time of presentation, culprit artery, and post-PCI decline in LV function were presented as frequencies and percentages. Data was stratified for age, gender, time of presentation,

culprit artery, and risk factors. Post-stratification, chi-square test was applied and *p*-value <0.05 was considered statistically significant.

RESULTS

This study included total 66 patients presenting with acute STEMI. As shown in Table-I; mean age of participants calculated was 51.21±6.95 years, among them, males comprised 45(68%), while females were 21(32%). Diabetes mellitus was present in 26(39%) patients, hypertension in 28(42%), and active smoking in 23(35%). Dyslipidemia was observed in 27(41%) patients, and 19(29%) had a positive family history of ischemic heart disease. Regarding the time of presentation, 30(45.5%) patients arrived at the hospital within six hours of symptom onset, whereas 36(54.5%) presented between six to twelve hours. The most frequently involved culprit artery was the left main artery, affected in 21(31.8%) cases, followed by right coronary artery (RCA) in 19(28.8%), left circumflex artery (LCX) in 11(16.7%), and left anterior descending (LAD) artery in 6(9.1%) patients. Multivessel involvement was observed in 9(13.6%) patients. The mean left ventricular ejection fraction (LVEF) before PCI was 53.27±3.67%, which declined slightly to 52.10±3.91% post-PCI, and 51.66±4.32% at the 4-week follow-up. A decline in LVEF was noted in 19(28.8%) patients.

Table-I: Summary of Study Variables (n=66)

Variables		Values
Age (years) Mean±SD		**51.21±6.95**
Gender	Male n(%)	45(68%)
	Female n(%)	21(32%)
Diabetics n(%)		26(39%)
Hypertensive n(%)		28(42%)
Active smokers n(%)		23(35%)
Dyslipidaemia n(%)		27(41%)
Family history of IHD n(%)		19(29%)
Time of presentation	<6 hours n(%)	30(45.5%)
	6-12 hours n(%)	36(54.5%)
Culprit artery	Left Main n(%)	21(31.8%)
	LAD n(%)	6(9.1%)
	RCA n(%)	19(28.8%)
	LCX n(%)	11(16.7%)
	Multi vessels disease n(%)	9(13.6%)
LVEF (%) Mean±SD	Pre PCI	53.27±3.67
	Post PCI	52.10±3.91
	At 4 weeks follow up	51.66±4.32
Decline in LVEF n(%)		19(28.8%)

RCA: Right coronary artery, LCX: Left circumflex, LAD: Left anterior descending, IHD: Ischemic heart disease, LVEF: Left ventricular ejection fraction

Data stratification as shown in Table-II based on effect modifiers revealed that decline in LVEF was not significantly associated with age (*p*=0.668) or gender (*p*=0.254). However, culprit artery showed statistically significant relationship with LVEF decline (*p*=0.001), with patients having multivessel disease more likely to experience decline compared to those with single-vessel involvement. Time of presentation was also significantly associated with LVEF decline (*p*=0.047); patients who presented later (6–12 hours) were more likely to have reduction in LVEF than those who presented earlier (<6 hours). Other factors such as smoking status (*p*=0.355), hypertension (*p*=0.257), diabetes (*p*=0.409), dyslipidemias (*p*=0.327), and family history of IHD (*p*=0.778) did not show statistically significant association with LVEF decline.

Table-II: Stratification of Left Ventricular Ejection Fraction (LVEF) Decline According to Effect Modifiers

		Decline in LVEF		*p*-value
		Yes frequency (%)	No frequency (%)	
Age	≤50 years	10(52.6%)	22(46.8%)	0.668
	>50 years	9(47.4%)	25(53.2%)	
Gender	Male	11(57.9%)	34(72.3%)	0.254
	Female	8(42.1%)	13(27.7%)	
Culprit Artery	Left main	6(31.6%)	15(31.9%)	0.001*
	RCA	1(5.3%)	18(38.3%)	
	LCX	2(10.5%)	9(19.1%)	
	LAD	3(15.8%)	3(6.4%)	
	Multivessels	7(36.8%)	2(4.3%)	
Presentation time	<6 hours	5(26.3%)	25(53.2%)	0.047*
	6-12 hours	14(73.7%)	22(46.8%)	
Smoking	Yes	5(26.3%)	18(38.3%)	0.355
	No	14(73.7%)	29(61.7%)	
Hypertension	Yes	6(31.6%)	22(46.8%)	0.257
	No	13(68.4%)	25(53.2%)	
Diabetes	Yes	6(31.6%)	20(42.6%)	0.409
	No	13(68.4%)	27(57.4%)	
Dyslipidemias	Yes	6(31.6%)	21(44.7%)	0.327
	No	13(68.4%)	26(55.3%)	
Family history of IHD	Yes	5(26.3%)	14(29.8%)	0.778
	No	14(73.7%)	33(70.2%)	

**statistically significant at p <0.05, RCA: Right coronary artery, LCX: Left circumflex, LAD: Left anterior descending, IHD: Ischemic heart disease, LVEF: Left ventricular ejection fraction*

DISCUSSION

In current study conducted on 66 STEMI patients who underwent primary PCI, post PCI decline in LVEF was observed in 28.8% participants, with significantly higher frequency was observed in those who presented late and had multivessel disease *p*= 0.047 and 0.001, respectively. LV function impairment following primary PCI for STEMI varies across studies. Liu *et al.*, reported notably higher frequency of left ventricular function decline—

54.3%—during long-term follow-up after primary PCI, which contrasts with the 28.8% observed in the current study.[13] This difference may be attributed to the longer follow-up duration in Liu *et al.,*'s study, allowing more time for adverse remodeling and deterioration of LV function to manifest. Additionally, study involving 4,044 patients found that 22% exhibited LV dysfunction at follow-up echocardiography.[11] Chimed *et al.,* however, reported post PCI LV impairment in only 7% patients at 6 months follow up.[14] Khademi *et al.,* demonstrated that although global LVEF improved overall at six weeks, 27 % of anterior-STEMI patients still had EF <35 %, and those with delayed door-to-balloon times showed minimal recovery.[15] Van *et al.,* reported that approximately 50% patients who underwent PCI developed LV remodeling.[16] Wohlfahrt *et al.,* have further confirmed that nearly half of first-MI survivors remain in "persistently low EF" cluster at one year, with multivessel disease and symptom-to-balloon time the dominant determinant.[17] Supporting current findings, AbdelHafez *et al.,* 2024 also revealed that patients with single-vessel disease show better recovery of LV function compared to those with multi-vessel involvement.[18] In line with current findings, reported that shorter presentation time was associated with improved LV function at follow-up.[19] REVIVED-BCIS2 trial underscored that in patients with extensive multivessel CAD and baseline EF ≤35%, multivessel PCI did not translate into meaningful EF improvement versus optimal medical therapy, highlighting limited potential for functional recovery once extensive ischemic injury is established.[20]

This study contributes new insights to existing literature by providing local data from setting where there is a paucity of outcome-based follow-up studies in STEMI patients undergoing primary PCI. The study emphasizes real-world frequency of LV function decline post-PCI in early post-intervention period, highlighting that nearly one-third of patients are at risk despite technically successful revascularization. Furthermore, it reinforces clinical relevance of pre-sentation time and coronary anatomy as independent predictors of post-PCI outcomes in STEMI, suggesting that tailored strategies for early detection and timely reperfusion particularly in multivessel disease—could meaningfully reduce the burden of post-infarction heart failure in similar populations.

Collectively, contemporary evidence supports our finding that timely reperfusion and single-vessel involvement favour preservation of LV function, while delayed presentation and multivessel disease are strongly associated with impaired post-PCI recovery. These insights highlight critical need for public awareness campaigns to reduce pre-hospital delays and support the implementation of individualized revascularization strategies in complex coronary anatomy to mitigate the long-term risk of heart failure.

CONCLUSION

This study highlights that significant proportion of patient's experience decline in left ventricular function following primary PCI for STEMI. The findings underscore the critical impact of delayed presentation and presence of multivessel coronary artery disease on post-procedural LV performance. These results emphasize the importance of early intervention and comprehensive assessment of coronary anatomy to optimize long-term cardiac function and outcomes in STEMI patients undergoing PCI.

Conflict of Interest: None.
Funding Source: None.

Authors' Contribution

Following authors have made substantial contributions to the manuscript as under:

SJD & SA: Data acquisition, data analysis, critical review, approval of the final version to be published.

AA & SAC: Study design, data interpretation, drafting the manuscript, critical review, approval of the final version to be published.

FAD & MT: Conception, data acquisition, drafting the manuscript, approval of the final version to be published.

Authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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