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FREQUENCY OF IMPROVEMENT IN LEFT VENTRICULAR EJECTION FRACTION AFTER PRIMARY PERCUTANEOUS CORONARY INTERVENTION IN PATIENTS PRESENTING WITH ST-SEGMENT ELEVATION MYOCARDIAL INFARCTION

Original Research

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Acknowledgement: The authors sincerely acknowledge the cooperation of all participants and the support provided by the Faisalabad Institute of Cardiology.

Conflict of Interest: None
Grant Support & Financial Support: None

ABSTRACT

Background: ST-segment elevation myocardial infarction (STEMI) is a critical cardiac emergency that often leads to impaired ventricular function and increased mortality. Primary percutaneous coronary intervention (PCI) has emerged as the gold-standard treatment for rapid myocardial reperfusion in STEMI, aimed at preserving left ventricular function. Left ventricular ejection fraction (LVEF) is a reliable prognostic marker for functional recovery and long-term outcomes post-revascularization. However, variability in LVEF response post-PCI continues to prompt investigation into its effectiveness across different patient populations.

Objective: To determine the improvement in left ventricular ejection fraction after primary percutaneous coronary intervention in patients presenting with ST-segment elevation myocardial infarction.

Methods: This descriptive cross-sectional study was conducted at the Department of Cardiology, Faisalabad Institute of Cardiology, Lahore, over a six-month period from October 2024 to March 2025. A total of 100 patients aged 30–80 years, of either gender, diagnosed with STEMI and undergoing primary PCI were included. Patients were evaluated for LVEF using transthoracic echocardiography before PCI and again 90 days post-intervention. Improvement was defined as a rise in LVEF greater than 10%. Data were collected through structured proformas and analyzed using SPSS version 27.

Results: The mean baseline LVEF was 32.9 ± 4.19%, which significantly improved to 44.72 ± 5.17% after 90 days of primary PCI ($p < 0.001$). An improvement in LVEF was observed in 87% (n=87) of the patients.

Conclusion: Primary PCI is an effective intervention that leads to significant improvement in left ventricular ejection fraction in patients presenting with STEMI, underscoring its role in myocardial recovery and prognostic enhancement.

Keywords: Cardiac Function, Left Ventricular Ejection Fraction, Myocardial Infarction, Percutaneous Coronary Intervention, Prognosis, Revascularization, STEMI.

INTRODUCTION

Heart failure (HF) remains a major public health burden globally, contributing significantly to morbidity and mortality across diverse populations (1). Among the leading causes of acute cardiovascular compromise is ST-elevation myocardial infarction (STEMI), a life-threatening manifestation of coronary artery disease that predisposes patients to adverse clinical outcomes, including arrhythmias, heart failure, and death. Despite its severity, remarkable advancements in interventional cardiology have substantially improved the prognosis of STEMI patients, primarily through the widespread adoption of primary percutaneous coronary intervention (PCI), which is now recognized as the gold standard of care in both American and European guidelines (2–6). This revascularization strategy has demonstrated superiority in restoring myocardial perfusion, thereby reducing infarct size and preserving ventricular function. Over the years, significant improvements in procedural techniques, pharmacological therapies, and patient triage systems have led to enhanced short- and long-term outcomes in STEMI care. However, despite these strides, predicting individual patient trajectories remains a clinical challenge, particularly in terms of left ventricular systolic function, which plays a pivotal role in determining prognosis (7). Left ventricular ejection fraction (LVEF) is one of the most widely accepted parameters used to evaluate systolic performance, and its prognostic significance is well-established in the post-infarction setting. Notably, approximately 40% of patients presenting with STEMI exhibit depressed LVEF at the time of hospital admission. Encouragingly, more than half of these individuals demonstrate meaningful recovery in LVEF within a year of undergoing PCI, an improvement that is independently associated with reductions in long-term cardiovascular and all-cause mortality (8).

Timely myocardial reperfusion is a critical determinant of favorable clinical outcomes in STEMI, as the therapeutic benefit of PCI is closely linked to the rapid restoration of coronary blood flow. Delays in treatment, often resulting from late hospital presentation or systemic inefficiencies, continue to compromise outcomes in routine clinical practice despite technological advancements (9). While LVEF is an essential marker of systolic function, emerging interest has turned toward diastolic parameters such as left ventricular end-diastolic pressure (LVEDP), which reflect the structural and hemodynamic consequences of myocardial injury at the microcirculatory level (10,11). These complementary metrics may offer a more nuanced understanding of myocardial recovery following intervention. Although current literature suggests that primary PCI can positively influence cardiac function by improving LVEF, evidence remains inconsistent, with some studies reporting negligible changes. This discrepancy highlights the need for further investigation, particularly within underrepresented populations where local data is scarce. Given these considerations, the present study aims to determine whether primary PCI significantly improves left ventricular ejection fraction in patients presenting with STEMI, thereby generating local evidence to guide future management strategies and optimize clinical outcomes.

METHODS

This descriptive cross-sectional study was conducted over a period of six months, from October 2024 to March 2025, at the Department of Cardiology, Faisalabad Institute of Cardiology, Lahore. A total of 100 patients were enrolled using a non-probability consecutive sampling technique. The sample size was determined using the WHO sample size calculator, with parameters set at a 95% confidence interval, a precision level (d) of 0.20, and a mean expected change in left ventricular ejection fraction (LVEF) of 10 ± 1% among patients with ST-elevation myocardial infarction (STEMI) (12). Patients between 30 and 80 years of age, of either gender, who presented with STEMI and underwent primary percutaneous coronary intervention (PCI) were included. STEMI was defined by the presence of ischemic chest pain lasting more than 30 minutes at rest, associated symptoms such as shortness of breath and diaphoresis, elevated cardiac biomarkers (troponin >100 IU and CK-MB >25 IU), and electrocardiographic evidence of ST-segment elevation greater than 1 mm. Patients were excluded if they had undergone high-risk cardiac procedures post-PCI (such as coronary artery bypass grafting, additional PCI, cardiac resynchronization therapy, or valvular interventions), or if they had died before day 60, which marked the beginning of the 90-day follow-up period.

Ethical approval for the study was obtained from the Institutional Review Board (IRB), and written informed consent was secured from all participants prior to inclusion. Baseline demographic and clinical data were recorded on a pre-structured proforma. This included age, gender, duration of STEMI symptoms, residential background, occupational status, lifestyle factors (such as smoking and alcohol

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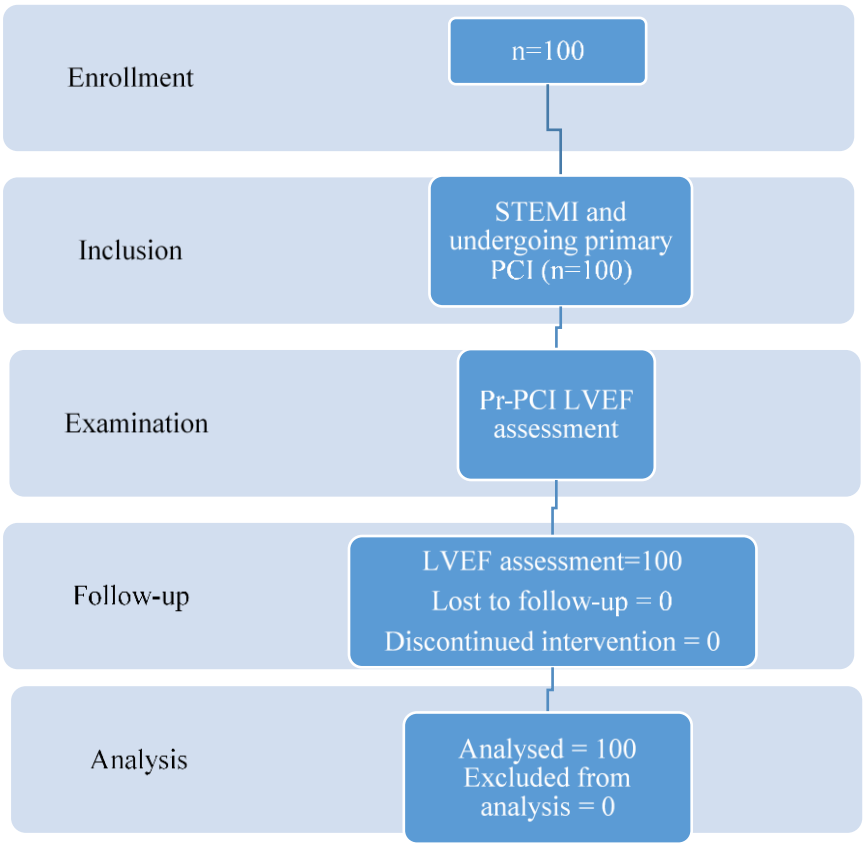
consumption), and comorbidities like diabetes mellitus, hypertension, dyslipidemia, and history of thrombolysis. All patients received standard care in accordance with institutional clinical protocols. LVEF was assessed using transthoracic echocardiography prior to the primary PCI procedure and was reassessed at a 90-day follow-up. The change in LVEF was computed as the difference between pre- and post-PCI values. A post-procedural increase in LVEF of more than 10% was considered indicative of clinically significant improvement. All echocardiographic evaluations were conducted by qualified personnel using standard methods to ensure accuracy and consistency. Data entry and statistical analysis were carried out using SPSS version 27. LVEF values before and after PCI were expressed as mean ± standard deviation. The frequency and percentage of patients demonstrating improvement were calculated. A paired sample t-test was applied to evaluate the statistical significance of changes in LVEF over time, with a p-value of ≤ 0.05 considered statistically significant.

Patient Flow Diagram (n= 100)



RESULTS

A total of 100 patients were included in the study. The mean age of the participants was 51.67 ± 14.28 years, ranging from 30 to 80 years. Males comprised 58% (n=58) of the study population, while females accounted for 42% (n=42). The average duration since STEMI was reported as 13.44 ± 6.99 months, with a minimum of 2 months and a maximum of 24 months. Thrombolytic therapy had been administered in 48% (n=48) of patients prior to primary PCI. In terms of residential distribution, 41% (n=41) of patients belonged to rural areas, 28% (n=28) were from urban localities, and 31% (n=31) resided in semi-urban regions. Occupational status revealed that 34% were housewives, 33% were involved in business, 21% were employed in jobs, and 6% each were either retired or street vendors. An equal distribution of physical activity levels was noted, with 50% reporting an active lifestyle and the remaining 50% leading a sedentary lifestyle. Regarding comorbidities, diabetes mellitus was present in 70% (n=70) and hypertension in 65% (n=65) of the

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participants. Smoking history was reported by 32% (n=32), while 7% (n=7) acknowledged alcohol consumption. Dyslipidemia was observed in 61% (n=61) of patients. Killip class I was identified in 51% (n=51) of the patients, and class II in 49% (n=49).

The mean left ventricular ejection fraction (LVEF) before primary PCI was 32.69 ± 4.19%, with recorded values ranging between 25.0% and 40.0%. At 90 days post-procedure, the mean LVEF had significantly improved to 44.72 ± 5.17%, with values spanning from 35.0% to 55.0%. The average change in LVEF was 0.26 ± 0.12, ranging from 0.02 to 0.49. This change was statistically significant with a p-value of <0.001. An improvement in LVEF greater than 10% was observed in 87% (n=87) of the patients, while 13% (n=13) did not demonstrate this level of functional recovery. Subgroup analysis was performed to explore the association between common comorbid conditions and improvement in LVEF following primary PCI. Patients with diabetes (n=70) showed a mean LVEF improvement comparable to those without diabetes (n=30), and the difference was not statistically significant (p = 0.593). Similarly, no significant difference was observed in LVEF recovery between hypertensive (n=65) and non-hypertensive patients (n=35) (p = 0.281). Furthermore, the degree of LVEF improvement did not significantly differ between patients categorized as Killip class I (n=51) and Killip class II (n=49) at presentation (p = 0.211).

Table 1: Descriptive statistics of socio-demographic and clinical parameters of the patients

		F (%), mean ± SD
Age (years)		51.67 ± 14.28 (30-80)
Gender	Male	58 (58%)
	Female	42 (42%)
Thrombolysis	Yes	48 (48%)
	No	52 (52%)
Residence	Rural	41 (41%)
	Urban	28 (28%)
	Semi Urban	31 (31%)
Occupation	Business	33 (33%)
	Job	21 (21%)
	Vender	6 (6%)
	House wife	34 (34%)
	Retired	6 (6%)
Life Style	Active	50 (50%)
	Sedentary	50 (50%)
Diabetes mellitus	Yes	70 (70%)
	No	30 (30%)
Hypertension	Yes	65 (65%)
	No	35 (35%)
Smoking	Yes	32 (32%)
	No	68 (68%)
Alcoholic	Present	7 (7%)
	Absent	93 (93%)
Dyslipidemia	Present	61 (61%)
	Absent	39 (39%)
Killip Class	I	51 (51%)
	II	49 (49%)
Duration of STEMI		13.44 ± 6.99 (2-24)

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Table 2: Pre and post evaluation of LVEF and change in LVEF (n = 100)

		Mean	Minimum	Maximum	p-value
LVEF	Before	32.69 ± 4.19	25.0	40.0	<0.001
	After	44.72 ± 5.17	35.0	55.0	
Change in LVEF			0.26 ± 0.12 (0.02-0.49)		

Table 3: Subgroup Analysis: LVEF Change by Comorbidities

Diabetes	Hypertension	Killip Class	N	Mean LVEF Change	SD
Yes	Yes	I	35	0.27	0.11
Yes	Yes	II	30	0.24	0.13
Yes	No	I	3	0.26	0.12
Yes	No	II	2	0.27	0.12
No	Yes	I	6	0.30	0.12
No	Yes	II	4	0.25	0.11
No	No	I	7	0.24	0.13
No	No	II	13	0.27	0.12

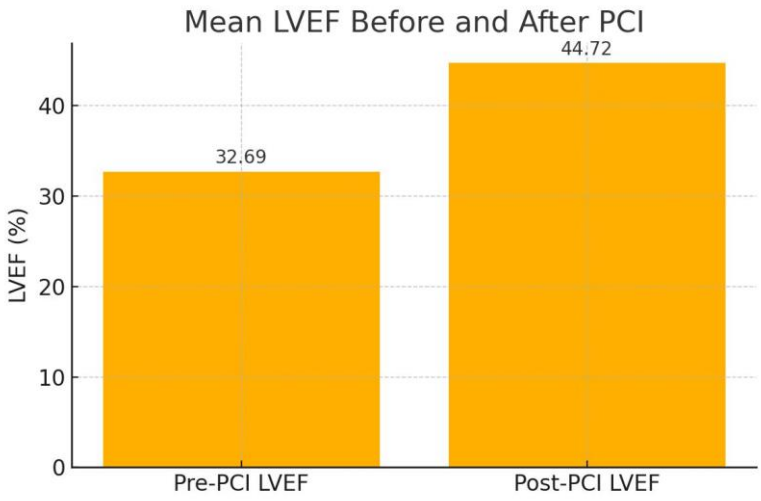

Figure 1 Mean LVEF Before and After PCI

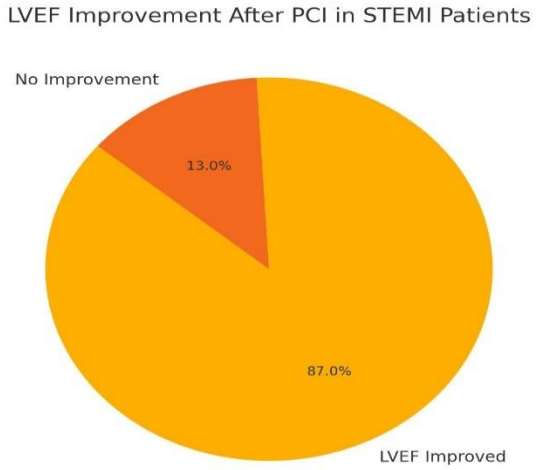

Figure 2 LVEF Improvement After PCI in STEMI Patients

DISCUSSION

The present study demonstrated a significant improvement in left ventricular ejection fraction (LVEF) among patients with ST-segment elevation myocardial infarction (STEMI) following primary percutaneous coronary intervention (PCI), with 87% of participants exhibiting enhanced ventricular function at 90-day follow-up. The mean LVEF rose from 32.9 ± 4.19% at baseline to 44.72 ± 5.17% post-intervention, reflecting a clinically and statistically significant recovery in myocardial function ($p < 0.001$). These findings are consistent with previously published data indicating that primary PCI not only restores coronary perfusion but also plays a pivotal role in improving left ventricular systolic performance in the subacute and chronic phases post-STEMI (13,14). LVEF recovery has been recognized as a reliable marker of favorable prognosis in patients with acute myocardial infarction. A prior study showed an improvement in LVEF from 35 ± 15% to 45 ± 14% at 90 days, with a mean change of 10 ± 1% after PCI (12), which aligns closely with the results observed in the current investigation. However, other studies have reported minimal or no significant difference between pre- and post-PCI LVEF, raising the possibility of inter-patient variability or the influence of unmeasured factors such as infarct size, timing

of reperfusion, and myocardial viability (15). For instance, one study indicated that baseline and post-procedural LVEF were 63.4% and 63.7%, respectively, suggesting negligible benefit in populations with preserved ventricular function prior to intervention.

Subsequent evidence further supports the heterogeneity of LVEF trajectories following PCI. In a group of STEMI patients managed with guideline-directed therapy, only a subset showed substantial LVEF recovery, while a comparable portion experienced persistent dysfunction or even deterioration at six-month follow-up. Notably, unfavorable ventricular remodeling was associated with a three-fold increase in mortality risk at 1.5 years, even after adjustment for infarct characteristics and baseline function (16). These observations highlight the prognostic value of LVEF changes beyond the immediate post-PCI phase and underscore the importance of identifying factors that influence such variability. Comparative data from other prospective evaluations indicate that although improvements in LVEF are common, not all patients benefit equally. Patients with baseline LVEF <40% appeared to derive the greatest prognostic advantage from an increase in LVEF, with a corresponding reduction in long-term all-cause and cardiac mortality. Median LVEF changes were highest in those with initially depressed function, and the mortality risk declined progressively with increasing ΔLVEF, particularly in those crossing the 5% improvement threshold (17,18). Another longitudinal study affirmed that in ischemic cardiomyopathy, even modest improvements in LVEF following revascularization were associated with meaningful reductions in mortality and heart failure-related hospitalizations, especially when LVEF gains exceeded 5% over baseline (19).

In contrast, not all studies concur on the impact of PCI on ventricular function. One investigation reported minimal change in LVEF post-PCI (from 48.47% to 49.14%, p = 0.2524), despite a high incidence of major adverse cardiovascular events (MACE) and microvascular obstruction (MVO) in the cohort, suggesting that mechanical reperfusion alone may not guarantee functional recovery in all cases (20). These inconsistencies highlight the need for more nuanced risk stratification and a multifactorial approach to post-STEMI care, integrating clinical, imaging, and biochemical parameters to predict response to PCI more accurately. A major strength of this study was the use of a uniform follow-up period and objective echocardiographic assessment to evaluate LVEF change. Additionally, the study included a representative sample with common comorbidities, enhancing the generalizability of findings to real-world settings. Subgroup analysis further suggested that variables such as diabetes, hypertension, and Killip class did not independently influence LVEF recovery, though larger studies are warranted to confirm these trends. Nonetheless, this study had some limitations. The lack of long-term follow-up restricted the ability to assess sustained improvements or delayed ventricular remodeling. Furthermore, the absence of infarct localization, extent of coronary involvement, and quantification of myocardial salvage may have masked key determinants of LVEF improvement. Also, echocardiographic interobserver variability and lack of advanced imaging (such as cardiac MRI) could have limited the precision of LVEF measurements. Future research should focus on longitudinal assessments of ventricular function, explore the role of adjunctive therapies to enhance myocardial recovery, and develop predictive models that incorporate baseline LVEF, comorbid burden, and procedural characteristics. Stratifying patients by risk may allow clinicians to personalize revascularization strategies and optimize clinical outcomes.

CONCLUSION

This study concluded that primary percutaneous coronary intervention serves as an effective therapeutic approach for patients presenting with ST-segment elevation myocardial infarction, resulting in notable recovery of left ventricular function. The findings reinforce the clinical value of timely intervention in preserving myocardial performance and support the continued use of PCI as a cornerstone in the acute management of STEMI. These results also highlight the potential for improved long-term cardiac outcomes when patients receive prompt, evidence-based revascularization, thereby contributing to better quality of life and reduced burden of cardiovascular disease.

AUTHOR CONTRIBUTION

Author	Contribution
Muhammad Shehbaz Amjad*	Substantial Contribution to study design, analysis, acquisition of Data Manuscript Writing Has given Final Approval of the version to be published
Shahid Abbas	Substantial Contribution to study design, acquisition and interpretation of Data Critical Review and Manuscript Writing Has given Final Approval of the version to be published

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