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Primary Percutaneous Coronary Intervention and Left Ventricular Function Recovery in Acute Myocardial Infarction

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ABSTRACT

Objective: Primary percutaneous coronary intervention (PCI) has emerged as the gold standard for the management of ST-segment elevation myocardial infarction (STEMI), significantly improving patient outcomes. The objective of this study was to assess the impact of primary PCI on left ventricular function recovery in Acute MI patients.

Methodology: A retrospective study was conducted at the Department of Cardiology, Hayatabad Medical Complex, Peshawar, from November 2023 to November 2024. A total of 300 patients (mean age: 61.1 ± 13.32 years; 60% male, 40% female) were included. Pre-PCI and post-PCI Left Ventricular Ejection Fraction (LVEF) were analyzed, along with the incidence of **microvascular obstruction (**MVO) and major adverse cardiovascular events (MACE). Statistical analysis was performed using paired t-tests and chi-square tests, with significance set at $p<0.05$.

Results: The mean pre-PCI LVEF was 48.47% (± 7.99), increasing to 49.14% (± 8.51) at follow-up ($p = 0.2524$). MVO was present in 56.33% of patients, while 49% experienced MACE. Gender differences in MACE incidence (male: 52%, female: 46%) were not statistically significant ($p >0.05$).

Conclusion: PCI alone did not significantly improve LVEF, indicating the need for additional therapeutic strategies. High rates of MVO and MACE highlight the necessity for comprehensive post-PCI management to enhance cardiac recovery.

Keywords: Left ventricular function, MACE, Microvascular Obstruction, Myocardial infarction,

Authors' Contribution:
[1,2]Conception; Literature research; manuscript design and drafting; [3,4]Critical analysis and manuscript review; [5]Data analysis; Manuscript Editing.

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Introduction

Acute myocardial infarction (AMI) remains a leading cause of morbidity and mortality worldwide, necessitating timely and effective treatment strategies. Primary percutaneous coronary intervention (PCI) has emerged as the gold standard for the management of ST-segment elevation myocardial infarction (STEMI), significantly improving patient outcomes. However, despite successful revascularization, many patients experience left ventricular (LV) dysfunction, which can contribute to long-term complications such as heart failure and increased mortality.[1,2] Understanding the predictors and mechanisms underlying LV function recovery post-PCI is crucial for optimizing therapeutic strategies and improving prognostic outcomes.

LV function recovery after primary PCI is influenced by factors such as myocardial injury, microvascular dysfunction, and patient characteristics.[3,4] studies

show that patients with significant LVEF improvement post-PCI have lower long-term cardiovascular mortality. Additionally, lower LVEDP after PCI predicts better clinical outcomes.[5,6]

Similarly, the role of myocardial work indices in assessing LV recovery has been highlighted, with studies suggesting that non-invasive myocardial work analysis can predict both segmental and global LV recovery following anterior STEMI.[7,8]

Despite successful revascularization, some patients still experience LV dysfunction due to microvascular obstruction and residual ischemia. This dysfunction is linked to adverse outcomes like heart failure and recurrent myocardial infarction.[9,10] A study at Chaudhary Pervaiz Ellahi Institute of Cardiology, Multan, found that primary PCI improves LVEF within three months, confirming its effectiveness.[11,12]

Cardiovascular diseases, including AMI, are on the rise in Pakistan. A study at the National Institute of Cardiovascular Diseases (NICVD) showed that early PCI intervention improves LVEF and reduces mortality compared to delayed treatment.[13,14] These findings underscore the importance of timely and efficient PCI procedures in optimizing patient outcomes in resource-limited settings.

The rationale behind this study stems from the need to further elucidate the factors influencing LV function recovery post-primary PCI. While significant progress has been made in identifying predictors of LV recovery, variations in individual patient responses necessitate further investigation. Understanding the interplay between myocardial strain, microvascular function, and inflammatory markers could offer new avenues for improving post-PCI cardiac rehabilitation strategies.[15,16]

This study aims to assess the impact of primary PCI on LV function recovery among patients presenting with acute myocardial infarction at the Department of Cardiology, Hayatabad Medical Complex Peshawar. The findings will contribute to the growing body of evidence on post-PCI cardiac recovery and inform clinical practices for improved patient management. The primary objective of this study is to evaluate the improvement in LVEF following primary PCI in patients with acute myocardial infarction.

Methodology

This retrospective study was conducted at the Department of Cardiology, Hayatabad Medical Complex, Peshawar. Data were collected from hospital records, ensuring a comprehensive review of patient outcomes following primary PCI.

Study Duration: The study covered a duration of one year, from November 2023 to November 2024.

Sample Size: The sample size was determined using the WHO sample size calculation method. Based on a previous study, which reported a LVEF recovery rate of approximately 54% in post-PCI patients,[1] a confidence level of 95% and a margin of error of 5% were used to calculate an adequate sample size. A total of 300 patients were included, with 150 patients exhibiting LVEF recovery and 150 patients not demonstrating significant improvement post-PCI.

Inclusion and Exclusion Criteria: Patients diagnosed with AMI and treated with primary PCI within 12 hours of symptom onset were included. Only patients with complete pre-procedural and post-procedural echocardiographic data were considered. Patients with a history of prior myocardial infarction, pre-existing heart failure, severe valvular heart disease, or significant renal dysfunction (eGFR <30 ml/min/1.73m^2) were excluded. Additionally, patients who did not undergo follow-up echocardiography at one-year post-PCI were excluded from the analysis.

Data Collection: Data were collected retrospectively from hospital electronic and paper records. Patient demographics, clinical presentation, angiographic findings, procedural details, and echocardiographic assessments were extracted. LVEF was recorded at baseline and at

one-year post-PCI using Simpson's biplane method. Additional variables, such as infarct size, culprit artery, and presence of microvascular obstruction, were also documented.

Study Variables and Definitions

Primary Outcome: LVEF recovery, defined as an increase in LVEF ≥5% from baseline.

Secondary Outcomes: Incidence of Major Adverse Cardiovascular Events (MACE), including heart failure hospitalization, recurrent myocardial infarction, and cardiovascular mortality.

Microvascular Obstruction (MVO): Defined as the presence of persistent myocardial hypoperfusion despite successful epicardial revascularization.

LV Dysfunction: Defined as an LVEF <50% at baseline echocardiography.

Statistical Analysis: Data were analysed using SPSS version 26.0. Continuous variables were expressed as mean ± standard deviation and compared using the independent t-test. Categorical variables were presented as frequencies and percentages and analysed using the chi-square test. A logistic regression model was used to identify independent predictors of LVEF recovery. A p-value of <0.05 was considered statistically significant.

Ethical approval for the study was obtained from the Ethical & Research Committee of Hayatabad Medical Complex, Peshawar (ERB# 2186) Dated 06 September 2023. Since the study involved retrospective data collection, a waiver of informed consent was granted by the ethics board. However, patient confidentiality was strictly maintained in accordance with institutional guidelines and the Declaration of Helsinki.

Results

Overview and Patient Count: A total of 300 patients participated in the study, conducted from July 2017 to June 2018. The mean age of the patients was 61.1± 13.32 years with ages ranging from 40 to 85 years. The cohort consisted of 60% male and 40% female patients. The mean pre-PCI LVEF was 48.47%± 7.99%, and the mean post-PCI LVEF was 49.14% ±8.51%. At the time of follow-up, 56.33% of patients exhibited Microvascular Obstruction (MVO), and 49% experienced MACE. These clinical characteristics were analyzed to assess the impact of PCI on left ventricular function and overall cardiovascular health, as outlined in the study objectives.

LVEF Improvement: The mean pre-PCI LVEF was 48.47%, and after a 1-year follow-up, the mean LVEF increased to 49.14%, with an average change of 0.47%. A paired t-test was performed to compare pre-PCI and post-PCI LVEF. This result indicates that the change in LVEF was not statistically significant, suggesting that PCI did not lead to a meaningful improvement in left ventricular function within the study period.

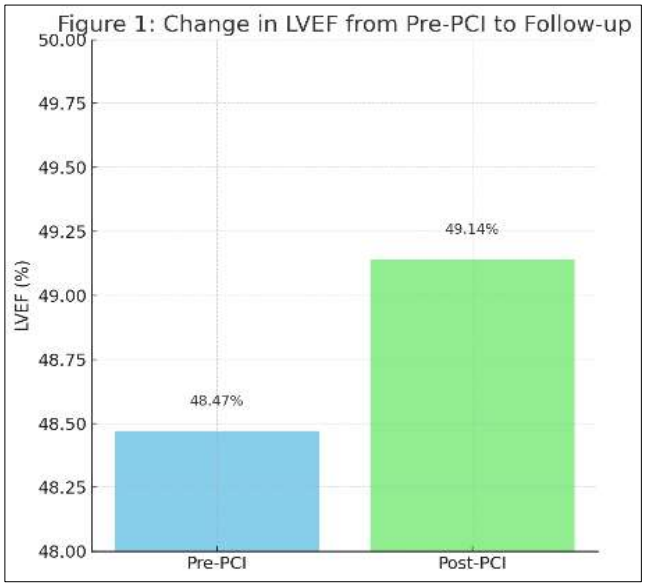

Figure 1. Change in LVEF from Pre-PCI to Follow-up

MACE (Major Adverse Cardiovascular Events)

Out of the 300 patients, 153 patients (51%) did not experience any MACE, while 147 patients (49%) had at least one MACE during the follow-up period. This distribution highlights that a nearly equal proportion of patients experienced serious cardiovascular complications despite undergoing PCI, reflecting the challenges in reducing such

events even after intervention. This finding is detailed in Figure 2.

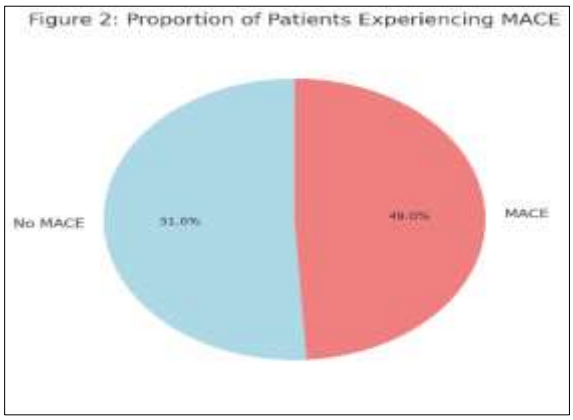

Figure 2. Proportion of Patients Experiencing MACE Microvascular Obstruction (MVO)

In terms of MVO, 169 patients (56.33%) showed signs of microvascular obstruction post-PCI, while 131 patients (43.67%) did not. This finding suggests that more than half of the cohort developed MVO, which is commonly associated with worse clinical outcomes. These results are summarized in Table I.

Table 1 Prevalence of MVO in Patients Post-PCI		
MVO Status	**Number of Patients**	**Percentage (%)**
MVO Present	169	56.33
MVO Absent	131	43.67

Table II. Gender Distribution and MACE Incidence			
Gender	**Total Patients**	**MACE Incidence (%)**	**p-value**
Male	180	52.00	0.174
Female	120	46.00	

Gender Distribution and PCI Outcomes: The gender distribution within the patient cohort was such that 60% were male and 40% were female. The analysis revealed that males had a slightly higher incidence of MACE (52% compared to 46% in females), although this difference was not statistically significant (p-value = 0.174). This information is presented in Table II.

Statistical Analysis for Clinical Outcomes: A paired t-test was used to assess LVEF changes indicating no significant difference (p>0.05). Descriptive statistics were applied to MACE and MVO distributions, with no additional statistical tests performed. PCI resulted in a minor but non-significant improvement in LVEF (p >0.05. 49% of patients experienced MACE, highlighting the need for ongoing management post-PCI. 56.33% of patients had MVO, which is linked to poorer outcomes. Gender differences in MACE incidence were minimal and not statistically significant, suggesting other factors that may influence outcomes.

Discussion

The present study assessed the impact of primary PCI on left ventricular function recovery in patients with AMI. A total of 300 patients were included, with a mean age of 61.1 years. The study found that while there was a slight increase in LVEF from 48.47% to 49.14%, this change was not statistically significant (p = 0.2524). Additionally, 56.33% of patients exhibited MVO, and 49% experienced MACE within the follow-up period. Gender differences in MACE incidence were minimal and did not reach statistical significance. These findings highlight the ongoing challenges in achieving meaningful cardiac recovery post-PCI and emphasize the need for improved post-procedural strategies to enhance patient outcomes.

The results of this study align with previous findings that indicate only marginal improvements in LVEF following PCI. A study found that 54% of patients exhibited LVEF recovery post-PCI, a percentage close to our observed rates.[1] However, our study found that the mean LVEF improvement was not significant, suggesting that additional factors such as microvascular obstruction may play a critical role in cardiac recovery.

Additionally, a study emphasized the role of GLS in predicting myocardial recovery, an area not fully explored in our study.[5] Internationally, similar studies have reported varying degrees of post-PCI LV function improvement. A study demonstrated that myocardial work indices could predict LV

recovery, highlighting the potential for non-invasive assessment tools.[7] Despite extensive research on PCI outcomes globally, limited studies have been conducted in Pakistan to evaluate its impact on LV function recovery. The current study contributes to the limited body of literature on the subject in a local population and highlights the need for further research tailored to Pakistan's healthcare system and patient demographics.

Some research has been conducted in Pakistan regarding PCI and cardiac recovery. A study at Chaudhary Pervaiz Ellahi Institute of Cardiology found significant LVEF improvement three months post-PCI.[11] Similarly, a study at the National Institute of Cardiovascular Diseases reported better LVEF recovery with early PCI intervention.[13] However, these studies primarily focused on short-term improvements, whereas our study provides a broader assessment at one-year follow-up.

The results of this study underscore the complexity of post-PCI cardiac recovery. While PCI is the gold standard for AMI management, persistent LV dysfunction remains a challenge. Several factors, including MVO and infarct size, influence recovery, and our findings suggest that these factors significantly impact patient outcomes. Previous literature supports the notion that adjunctive therapies, such as pharmacological interventions targeting MVO, may enhance cardiac recovery.[15]

The lack of significant LVEF improvement despite PCI suggests that procedural success alone is not sufficient for long-term myocardial recovery. Similarly, Liu et al. (2023) reported that around 45.7% of patients experienced an improvement in LV function after PCI.[17] The high prevalence of MVO (56.33%) and MACE (49%) in our cohort indicates that additional interventions, such as cardioprotective medications and tailored rehabilitation programs, may be necessary. These findings align with studies advocating for comprehensive post-PCI management strategies to improve outcomes.[18]

This study has several limitations. First, its retrospective nature limits causal inferences. Second, the study was conducted at a single center, potentially restricting the generalizability of the findings. Additionally, follow-up echocardiographic assessments were limited to one year; longer-term evaluations could provide further insights into LV function recovery.

Conclusion

This study assessed the impact of primary PCI on left ventricular function recovery in patients with acute myocardial infarction. The findings indicate that while PCI is an essential intervention for revascularization, its effect on long-term LVEF improvement remains limited. The study observed a marginal, statistically insignificant increase in LVEF post-PCI, highlighting the need for additional therapeutic strategies to enhance cardiac recovery. The high prevalence of MVO and MACE further underscores the complexity of post-PCI cardiac outcomes.

Future research should incorporate multi-center trials with larger sample sizes and explore novel therapeutic approaches to mitigate post-PCI complications. Additionally, the role of genetic and lifestyle factors in LV recovery in Pakistani patients warrants further investigation.

References

1. Otero-Garciá O, Cid-Álvarez AB, Juskova M, Álvarez-Álvarez B, Tasende-Rey P, Gude-Sampedro F, et al. Prognostic impact of left ventricular ejection fraction recovery in patients with ST-segment elevation myocardial infarction undergoing primary percutaneous coronary intervention: Analysis of an 11-year all-comers registry. Eur Hear J Acute Cardiovasc Care. 2021;10(8):898–908. https://doi.org/10.1093/ehjacc/zuab058
2. Otero L, Fernández B, Pena XS, Salvado G, Agra R, Álvarez C, et al. Prognostic impact of left ventricular ejection fraction recovery in patients undergoing pecutaneous aortic valve replacement. Eur Heart J. 2022 Oct 1;43(Supplement_2):ehac544-2093; https://doi.org/10.1093/eurheartj/ehac544.2093

3. Bhatti UH, Naseeb K, Khan MN, Mal V, Baqai MA, Karim M, Khan MA, Saghir T. Improvement in LV end-diastolic pressure after primary PCI and its impact on patients' recovery. The British Journal of Cardiology. 2023 Nov 29;30(4):43 .https://doi.org/10.54112/bcsrj.v2024i1.1172
4. Schäfer A, König T, Bauersachs J, Akin M. Novel therapeutic strategies to reduce reperfusion injury after acute myocardial infarction. Curr Probl Cardiol. 2022;101398. https://doi.org/10.1016/j.cpcardiol.2022.101398
5. Attar A, Zahed M, Hosseinpour A, Azami P, Kamalpour J, and Zamirian M et al. Predictive Value of Global Longitudinal Strain on the Recovery of Left Ventricular Function Following ST-Segment Elevation Myocardial Infarction. Shiraz E Med J . 2024;25(4). https://doi.org/10.5812/semj-142307
6. Holzknecht M, Reindl M, Tiller C, Reinstadler S, Lechner I, and Pamminger M, et al. Global longitudinal strain improves risk assessment after ST-segment elevation myocardial infarction: a comparative prognostic evaluation of left ventricular functional parameters. Clin Res Cardiol. 2021;110:1599–611. https://doi.org/10.1007/s00392-021-01855-6
7. Meimoun P, Abdani S, Stracchi V, Elmkies F, Boulanger J, and Ghannem M, et al. Usefulness of non-invasive myocardial work to predict left ventricular recovery and acute complications after acute anterior myocardial infarction treated by primary percutaneous intervention. Arch Cardiovasc Dis Suppl. 2021;13(1):56. https://doi.org/10.1016/j.acvdsp.2020.10.053
8. Meimoun P, Abdani S, Stracchi V, Elmkies F, Boulanger J, Botoro T, et al. Usefulness of Noninvasive Myocardial Work to Predict Left Ventricular Recovery and Acute Complications after Acute Anterior Myocardial Infarction Treated by Percutaneous Coronary Intervention. J Am Soc Echocardiogr. 2020;33(10):1180–90. https://doi.org/10.1016/j.echo.2020.07.008
9. Darwesh MAEM, Ibrahim IK, Allah TMA, Salama MM. Predictors of Left Ventricular Dysfunction after Percutaneous Primary Coronary Intervention in Acute Anterior Myocardial Infarction. Cardiol Angiol An Int J. 2022;83–91. https://doi.org/10.9734/ca/2022/v11i430210.
10. Bordy M, Fahmy AGF. Predictors of left ventricular systolic dysfunction after primary percutaneous coronary intervention for patients with left anterior descending artery occlusion. J Med Sci Res. 2021;4:294 300. https://doi.org/10.4103/JMISR.JMISR_89_20
11. Ramzan M, Razzaq A, Shehzad A, Javed K, Jahanzaib, Saed A Bin et al. Recovery of Left Ventricular Function in Cases of Primary Angioplasty for Acute Myocardial Infarction. J Fatima Jinnah Med Univ. 2022;16(4):176-179. https://doi.org/10.37018/PMGF5081
12. Wu W, Biery D, Singh A, Divakaran S, Berman A, Ayuba G, et al. Recovery of Left Ventricular Systolic Function and Clinical Outcomes in Young Adults With Myocardial Infarction. J Am Coll Cardiol. 2020;75 22:2804–15. https://doi.org/10.1016/j.jacc.2020.03.074
13. Shaikh SA, Ismail M, Hassan M, Khurshed Shaikh J, Hashim M, Hussain Sahito S, et al. Impact of Early Invasive Strategy on Left Ventricular Function Recovery in Acute Myocardial Infarction Patients in Pakistan. Cureus. 2024 Aug 25; https://doi.org/10.7759/cureus.67778
14. Shaikh S, Bhatt L, Barve K. Attenuation of isoproterenol-induced cardiotoxicity in rats by Narirutin rich fraction from grape fruit. Phytomedicine. 2019;55:222–8. https://doi.org/10.1016/j.phymed.2018.06.037
15. Batra MK, Malik MA, Khan KA, Rai L, Kumar R, Shah JA, et al. Left ventricular functional remodeling after primary percutaneous coronary intervention. J Cardiovasc Echogr. 2022 Jan;32(1):12–6. https://doi.org/10.1016/j.ahj.2010.10.010
16. Van Der Bijl P, Abou R, Goedemans L, Gersh B, Holmes D, Marsan A, et al. Left Ventricular Post-Infarct Remodeling: Implications for Systolic Function Improvement and Outcomes in the Modern Era. JACC Heart Fail. 2019; https://doi.org/10.1016/j.jchf.2019.08.014
17. Liu C, Guo M, Cui Y, Wu M, Chen H. Incidence and predictors of left ventricular function change following ST-segment elevation myocardial infarction. Front Cardiovasc Med. 2023;10. https://doi.org/10.3389/fcvm.2023.1079647
18. Taha MB, Jeng EI, Salerno M, Moguillansky D, Keeley EC, Al-Ani MA. Left Ventricular Strain Is Associated With Myocardial Recovery Following ST-Elevation Myocardial Infarction, a Prospective Longitudinal CMR Study. Front Cardiovasc Med. 2022;9. https://doi.org/10.3389/fcvm.2022.842619