

EARLY SUCCESSFUL PRIMARY PERCUTANEOUS CORONARY INTERVENTION ON LEFT VENTRICULAR EJECTION FRACTION IN PATIENTS WITH ST-ELEVATION MYOCARDIAL INFARCTION

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(Received, 13th May 2024, Revised 22nd September 2024, Published 15th October 2024)

Abstract: Early intervention in patients with ST-elevation myocardial infarction (STEMI) is crucial for preserving left ventricular function and improving patient outcomes. Primary percutaneous coronary intervention (PPCI) has become the standard of care, and the timing of intervention significantly influences recovery and long-term prognosis. **Objective:** This study aimed to evaluate the impact of early successful primary percutaneous coronary intervention (PPCI) on left ventricular ejection fraction (LVEF) in patients presenting with STEMI. **Methods:** A prospective cohort study was conducted on 116 STEMI patients undergoing PPCI at a tertiary care hospital. The patients were categorized into two cohorts: early presenters (n=67) who received PPCI within 6 hours of symptom onset and late presenters (n=49) who received PPCI after 6 hours. Baseline characteristics, procedural outcomes, Thrombolysis in Myocardial Infarction (TIMI) flow grades, and LVEF measurements were assessed at presentation and two months post-PPCI using transthoracic echocardiography. The primary outcome was the change in LVEF from baseline to follow-up, and the secondary outcome was the distribution of TIMI flow grades achieved during PPCI. Statistical analysis was performed using appropriate tests to compare outcomes between the two groups. **Results:** Early presenters demonstrated significantly better outcomes compared to late presenters. At presentation, the mean LVEF in the early group was higher ($45.67 \pm 1.73\%$) compared to the late group ($36.94 \pm 1.25\%$) ($p = 0.0001$). At the two-month follow-up, the LVEF improved significantly in both groups, with early presenters achieving an LVEF of $56.24 \pm 1.73\%$, which was notably higher than the LVEF of late presenters ($45.12 \pm 1.42\%$) ($p = 0.0001$). In terms of coronary reperfusion, 62.7% of early presenters achieved TIMI grade 3 flow compared to 26.5% of late presenters ($p = 0.0001$), indicating better coronary artery perfusion in the early intervention group. **Conclusion:** Early successful PPCI in STEMI patients is associated with superior recovery of left ventricular function and improved coronary reperfusion compared to delayed intervention. Patients who received PPCI within 6 hours of symptom onset demonstrated significantly higher LVEF at follow-up and achieved better TIMI flow grades, highlighting the critical importance of minimizing treatment delays in STEMI management.

Keywords: ST-elevation myocardial infarction, primary percutaneous coronary intervention, left ventricular ejection fraction, TIMI flow grade, early intervention, myocardial reperfusion.

Introduction

Coronary artery disease (CAD) ranks among the primary causes of mortality. Primary percutaneous coronary intervention (PCI) is a non-surgical, invasive method aimed at alleviating the constriction or blockage of the coronary artery to enhance blood flow to ischemic tissue (1, 2). This is typically accomplished by many techniques, with the most prevalent being balloon angioplasty of the constricted segment or the placement of a stent to maintain arterial patency. Primary PCI has been fundamental in the treatment of patients with STEMI, markedly enhancing clinical outcomes and decreasing mortality rates linked to this acute coronary syndrome (3-5).

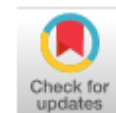
STEMI is defined by the swift emergence of chest discomfort resulting from the total blockage of a coronary artery, causing myocardial ischemia and eventual necrosis if not urgently treated. The prompt restoration of coronary blood flow is essential, as delays may lead to significant myocardial injury, especially impacting the left ventricular

ejection fraction (LVEF), a vital indicator of long-term cardiac function and survival (6-8).

Recent developments in PCI procedures, along with concomitant medication, have facilitated fast reperfusion and enhanced procedural success rates. Research indicates that prompt intervention preferably within the initial hours of symptom emergence enhances myocardial preservation, maintains left ventricular functionality, and reduces the likelihood of consequences including heart failure and arrhythmias (9, 10). Research indicates that attaining an optimal outcome during primary PCI, characterized by the successful restoration of blood flow with minimal residual stenosis and the absence of significant complications, correlates with positive results, including enhanced LVEF and a decreased occurrence of major adverse cardiac events (MACE) (11, 12).

The assessment of LVEF using the Simpson method is deemed effective, and a proficient echocardiographer is essential for observing the border of the endocardial line.

[Citation: Jan, M.T., Khan, M.A., Noman, M., Ullah, H., Alam, K., Riaz, M., Haq, I.U., Afzal, S., (2024). Early successful primary percutaneous coronary intervention on left ventricular ejection fraction in patients with st-elevation myocardial infarction. *Biol. Clin. Sci. Res. J.*, 2024: 1225. doi: <https://doi.org/10.54112/bcsrj.v2024i1.1225>]



Tissue Doppler Echocardiography offers novel features for the observation and diagnosis of LVSD, while facilitating quantitative assessment of myocardial function with adequate resolution time, independent of traditional echocardiographic evaluations (13).

STEMI is a severe disorder marked by rapid myocardial damage resulting from extended ischemia, potentially causing considerable and enduring dysfunction of cardiac performance, especially impacting LVEF, a crucial measure of cardiac health and prognosis. The justification for examining early effective primary percutaneous coronary intervention (PCI) in patients with STEMI and its effect on LVEF is rooted in the imperative to enhance outcomes in this high-risk group. By focusing on the relationship between early intervention and LVEF, this research seeks to contribute to the body of evidence supporting aggressive treatment strategies in STEMI, ultimately enhancing patient survival and quality of life.

Methodology

The study was designed as a prospective cohort study, conducted at Cardiology ward of Hayatabad Medical Complex, Peshawar, Pakistan from April 2023 to April 2024. Patients were enrolled based on their time of presentation to the hospital following the onset of symptoms. They were divided into two groups: early presenters, who arrived within six hours of symptom onset, and late presenters, who presented between six and twenty-four hours after symptom onset. The inclusion criteria consisted of adult patients having age ≥ 40 years, diagnosed with STEMI, whose symptoms began within the previous twenty-four hours, and who were suitable candidates for PPCI. Patients with a history of myocardial infarction, previous coronary interventions such as PCI or significant complications related to STEMI, such as ventricular septal rupture or severe left ventricular failure requiring advanced support, were excluded from the study. Additionally, patients with multi-vessel disease or involvement of non-dominant coronary vessels were also excluded to maintain consistency in the analysis.

All enrolled patients underwent PPCI following standard procedural guidelines to ensure optimal management of the infarct-related artery. Coronary reperfusion was evaluated during the procedure by assessing the TIMI flow grade. LVEF was measured using transthoracic echocardiography at the time of presentation and again at follow-up, which occurred two to three months after the intervention. The

Simpson's method was used to calculate LVEF, providing an accurate estimation of left ventricular systolic function. These follow-up echocardiograms allowed for an assessment of the recovery of myocardial function over time, enabling us to compare the effects of early versus late intervention.

The major outcome was the change in LVEF between presentation and follow-up. Secondary outcomes included the TIMI flow grade achieved during PPCI. In addition to procedural details, data on patient demographics and comorbid conditions, such as diabetes and hypertension. Statistical analysis was performed to compare the outcomes between the two groups. Independent sample t-tests were used to assess continuous variables like LVEF, while chi-square tests were employed for categorical variables, such as TIMI grade.

Results

The study included 116 patients, with a mean age of 58.95 ± 8.89 years. Among these patients, 67 (57.8%) arrived early at the hospital, while 49 (42.2%) arrived late. In terms of gender distribution, 70 (60.3%) were male and 46 (39.7%) were female. Comorbid conditions were noted, with 33 (28.4%) patients having diabetes and 40 (34.5%) suffering from hypertension. Smoking was present in 29 (25.0%) patients, while 87 (75.0%) were non-smokers.

TIMI (Thrombolysis In Myocardial Infarction) grading during PPCI showed a notable difference between early and late arrivals. In the early arrival group, none of the patients had TIMI 0-1, while 25 (37.3%) had TIMI 2 and 42 (62.7%) had TIMI 3. In contrast, among late arrivals, 16 (32.7%) had TIMI 0-1, 20 (40.8%) had TIMI 2, and 13 (26.5%) had TIMI 3. These differences in TIMI grades between early and late arrivals were statistically significant, with a p-value of 0.0001.

The LVEF, an important measure of heart function, was recorded at both presentation and at a two-month follow-up. Upon arrival at the hospital, the mean LVEF for the early arrival group was $45.67 \pm 1.73\%$, whereas it was notably lower at $36.94 \pm 1.25\%$ in the late arrival group. At the two-month follow-up, there was a marked improvement in LVEF for both groups, with the early arrival group having a mean LVEF of $56.24 \pm 1.73\%$, and the late arrival group showing a mean of $45.12 \pm 1.42\%$. The difference between the early and late arrival groups in LVEF at both presentation and follow-up was highly notable, with a p-value of 0.0001 in both instances.

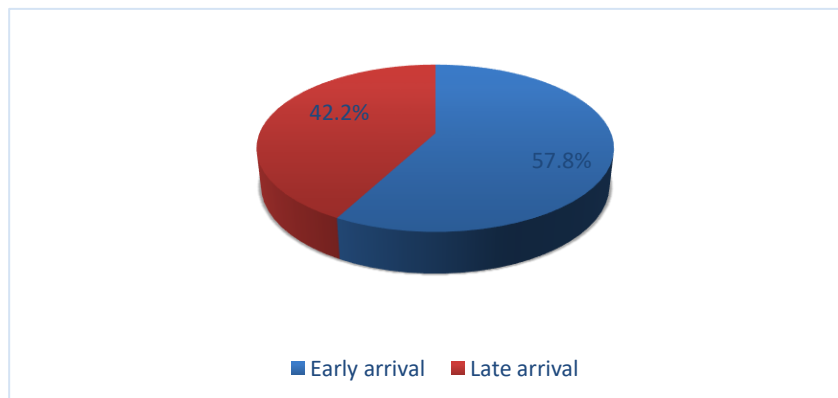


Figure 1 Distribution of patients according to the arrival at the hospital

Table 1 Baseline characteristics

| Baseline characteristics | | Frequency | Percentage |
|--------------------------|---------------|-----------|------------|
| Arrival | Early arrival | 67 | 57.8% |
| | Late arrival | 49 | 42.2% |
| Patient's Gender | Male | 70 | 60.3% |
| | Female | 46 | 39.7% |
| Diabetes | Yes | 33 | 28.4% |
| | No | 83 | 71.6% |
| Hypertension | Yes | 40 | 34.5% |
| | no | 76 | 65.5% |
| Smoking status | Yes | 29 | 25.0% |
| | No | 87 | 75.0% |

Table 2 TIMI grading according to the arrival at the hospital

| | | Arrival at hospital | | | | P value |
|------------------|----------|---------------------|------------|--------------|------------|---------|
| | | Early arrival | | Late arrival | | |
| | | Frequency | Percentage | Frequency | Percentage | |
| TIMI during PPCI | TIMI 0-1 | 0 | 0.0% | 16 | 32.7% | 0.0001 |
| | TIMI 2 | 25 | 37.3% | 20 | 40.8% | |
| | TIMI 3 | 42 | 62.7% | 13 | 26.5% | |

Discussion

In analyzing the impact of early versus late presentation of patients with ST-elevation myocardial infarction (STEMI) treated with primary percutaneous coronary intervention (PPCI), our study aligns with several findings from similar research. In our cohort, early presenters were defined as those arriving at the hospital within six hours of symptom onset, while late presenters arrived between six to twenty-four hours. This time frame significantly affected both the clinical outcomes, particularly with respect to TIMI (Thrombolysis in Myocardial Infarction) grade and left ventricular ejection fraction (LVEF).

The study conducted by Haq MR et al. supports our findings regarding the superiority of early PPCI. In their study, early presenters (within six hours) achieved a statistically significant higher rate of TIMI grade III flow (100% vs. 85%, $p = 0.02$) and better LVEF improvement compared to late presenters. At presentation, the LVEF for early presenters was $45.49 \pm 3.99\%$, significantly better than the $35.25 \pm 3.85\%$ observed in late presenters ($p = 0.001$). This difference persisted at the three-month follow-up, where early presenters had a mean LVEF of $55.66 \pm 0.92\%$, compared to $45.75 \pm 1.44\%$ in the late presenters ($p = 0.001$). (13) These findings are in agreement with our results, where early presenters had significantly better LVEF both at presentation ($45.67 \pm 1.73\%$ vs. $36.94 \pm 1.25\%$) and at the two-month follow-up ($56.24 \pm 1.73\%$ vs. $45.12 \pm 1.42\%$).

Similarly, the study by Ortolani P et al. also emphasizes the importance of minimizing treatment delay in STEMI patients. In their research, pre-hospital diagnosis and direct referral to PPCI resulted in a significant reduction in treatment delays and improved outcomes, particularly in patients presenting with cardiogenic shock. Although there was no overall difference in mortality, in the subset of patients with cardiogenic shock, early diagnosis and treatment within two hours resulted in a two-thirds reduction in mortality. (14) This reinforces the notion that rapid treatment can profoundly impact clinical outcomes, particularly in high-risk STEMI patients.

In a broader context, Nallamothu BK et al. highlighted the impact of delayed treatment in patients undergoing PPCI after transfer from non-PCI-capable hospitals. Their

analysis of the National Registry of Myocardial Infarction found that longer door-to-balloon times were associated with poorer outcomes. This study suggested that for every hour of delay beyond the recommended 90-minute door-to-balloon time, there was a corresponding decrease in survival. (15) This underscores the importance of timely intervention, further validating our findings that early presenters exhibit significantly better TIMI grades and LVEF improvements.

Moreover, the study by Vakili H et al. (2014) also found that patients with lower LVEF at presentation were at a higher risk for in-hospital adverse events. In their cohort, patients with LVEF less than 50% had significantly higher rates of cardiogenic shock and death compared to those with LVEF greater than 50%. (16) This mirrors our observation that early presenters, who generally had higher LVEF at presentation, experienced better outcomes compared to late presenters.

Our study's focus on the importance of early PPCI is further supported by findings from the study by Brodie BR et al. which demonstrated a strong correlation between complete ST-segment resolution and improved outcomes after PPCI. Patients with poor ST-segment resolution (>2 mm) had higher in-hospital mortality (11.6%) and significantly worse long-term outcomes compared to those with complete resolution (<1 mm), highlighting the value of early reperfusion. (17) This suggests that early intervention not only preserves myocardial function, as reflected by improved LVEF, but also reduces mortality in both the short and long term.

Conclusion

In conclusion, our study, along with supporting evidence, highlights the critical importance of early PPCI in improving outcomes for STEMI patients. Early presenters, treated within six hours of symptom onset, showed significantly better TIMI grades and LVEF improvements compared to late presenters. Reducing treatment delays through timely intervention, such as pre-hospital diagnosis and direct referral to PCI centers, can greatly improve both short-term and long-term outcomes, reducing the risk of left ventricular dysfunction and associated mortality.

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Declarations**Data Availability statement**

All data generated or analyzed during the study are included in the manuscript.

Ethics approval and consent to participate.

Approved by the department Concerned. (IRBEC-SWJA-090/23)

Consent for publication

Approved

Funding

Not applicable

Conflict of interest

The authors declared an absence of conflict of interest.

Authors Contribution**MUHAMMAD TUFAIL JAN**

Development of Research Methodology Design, Study Design, Review of Literature.

MUHAMMAD ASAD KHAN

Conception of Study, Review of manuscript, Final approval of manuscript.

MUHAMMAD NOMAN & HAMEED ULLAH

Manuscript revisions, Data analysis.

KHAN ALAM & MUHAMMAD RIAZ

Data entry and Data analysis, drafting article.

IHTISHAM UL HAQ & SEHRISH AFZAL

Data acquisition, and Manuscript drafting,

Coordination of collaborative efforts.

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