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Comparison of Immediate Versus Delayed Percutaneous Coronary Intervention on Recovery and Complications in Diabetic Patients with Acute ST Segment Elevation Myocardial Infarction: A Cross-Sectional Study

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ABSTRACT

Acute STEMI in diabetic patients leads to worse outcomes, making timely PCI crucial. However, the optimal timing (immediate vs. delayed) of percutaneous coronary intervention (PCI) for long-term recovery and complications in diabetic individuals is still being investigated. **Objectives:** To compare recovery and complication rates in diabetic acute STEMI patients undergoing immediate versus delayed PCI. **Methods:** This analytical cross-sectional study was conducted at a tertiary care hospital in Peshawar, Pakistan (October 2024 to March 2025), and enrolled 296 adult diabetic STEMI patients (aged ≥18 years) requiring PCI. After informed consent, data on demographics, medical history, procedural details, and post-PCI outcomes were collected via a structured questionnaire. Participants were categorized into immediate and delayed PCI groups, with statistical analysis using descriptive statistics and Chi-square tests to compare outcomes. **Results:** A total of 296 diabetic STEMI patients were enrolled, with 32.1% undergoing immediate PCI and 67.9% delayed PCI. The mean age was 55.89 ± 11.57 years, and 77% had type 2 diabetes. The delayed PCI group included a higher percentage of male; however, this variation was not significant. Baseline LVEF did not differ significantly (immediate: 40.54 ± 6.49 vs. delayed: 41.33 ± 7.23, $p>0.05$). Both groups showed significant post-PCI LVEF improvement (immediate: 49.12 ± 7.10, delayed: 50.85 ± 6.80), but the intergroup difference remained non-significant. No statistically significant differences were observed in intra- or post-procedural complications between the groups. **Conclusions:** In diabetic STEMI patients, a slight clinical delay in PCI did not significantly impact functional recovery (LVEF improvement) or increase intra- and post-procedural complications when compared to immediate intervention.

INTRODUCTION

Acute Coronary Syndrome (ACS), encompassing unstable angina and myocardial infarction, is characterized by reduced myocardial perfusion, which significantly contributes to adverse cardiovascular events [1]. Globally, cardiovascular illnesses are the primary cause of mortality, with over 100,000 fatalities each year. The situation is similar in Pakistan, where nearly one in five adults is estimated to suffer from some form of cardiovascular disease [2]. According to the WHO, cardiovascular diseases (CVDs) will kill 23.6 million people by 2030, accounting for 7.4 million deaths in 2015. According to the American Heart Association, there is a heart attack every 40 seconds, a death every minute, and the annual costs amount to $200 billion [3]. Myocardial infarction (MI) is a critical coronary condition that can lead to sudden cardiac death. MI accounts for one-third to one-half of

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cardiovascular disease cases. One-third of MI cases present as ST-segment Elevation Myocardial Infarction, which requires immediate percutaneous coronary intervention [4]. Diabetes mellitus significantly increases the risk of coronary vascular disease, a leading cause of acute coronary syndromes [5]. Individuals with diabetes have a much higher likelihood of CAD, reported to be up to 10 times greater than that of the general population [6]. Patients with diabetes frequently present atypical clinical symptoms and face treatment delays during acute myocardial infarction, as they are at high risk for silent myocardial infarction [7]. Diabetes mellitus is associated with a significantly elevated risk of death and other sequelae, including stroke, deep sternal wound infections (DSWI), and renal failure. This cluster of comorbidities contributes to higher healthcare resource utilization, resulting in significantly greater healthcare expenditures compared to non-diabetic populations [8]. ST-segment elevation myocardial infarction represents a critical clinical presentation of coronary vascular disease, with outcomes influenced by left ventricular function, treatment strategies, and complications. However, timely reperfusion remains the most crucial factor [9]. Immediate primary percutaneous intervention is the gold standard for treating STEMI in diabetics [10]. Each thirty-minute delay in reperfusion is associated with an estimated one-year reduction in life expectancy [11, 12]. Diabetic patients with STEMI encounter unique pathophysiological and healing challenges that differentiate them from non-diabetic individuals, potentially impacting their recovery and complication rates post-PCI. Consequently, these patients who frequently undergo cardiovascular procedures experience reduced intervention efficacy and increased complication rates [13]. Nonetheless, PCI continues to provide substantial benefits for improving outcomes even after the golden time window [14]. Despite the consensus on timely reperfusion, the optimal timing for PCI is still debated in several areas. It is generally accepted that performing PCI within 12 hours of STEMI onset results in the best outcomes. In Pakistan, many individuals miss this ideal window due to elements such as incorrect diagnosis, geographic remoteness, and insufficient medical resources. Therefore, our research aims to compare the severity of complications, including adverse cardiovascular events, bleeding, and other procedure-related issues, between immediate and delayed percutaneous coronary intervention in individuals with acute coronary syndrome. Additionally, we assessed the difference in functional recovery between diabetic individuals who have Primary or Immediate or early PCI after acute STEMI and those who receive delayed PCI, as indicated by variations in left ventricular ejection fraction. This study aims to compare recovery and complication rates in diabetic acute STEMI patients undergoing immediate versus delayed PCI.

METHODS

This analytical cross-sectional study was conducted at the Peshawar Institute of Cardiology, a tertiary care hospital located in Peshawar, Pakistan, for six months from October 2024 to March 2025. Ethical approval was obtained from the Institutional Review Board (IRB) of the Peshawar Institute of Cardiology, under reference number IRC/24/113. A total of 296 adult patients were assessed for eligibility. Participants eligible for inclusion were required to be aged 18 years or older, of either sex, and have a confirmed diagnosis of both acute ST-segment elevation myocardial infarction (STEMI) and diabetes mellitus. Exclusion criteria included individuals who declined to provide informed consent or those with severe renal impairment, chronic obstructive pulmonary disease (COPD), or chronic liver disease, as these conditions could potentially confound the outcomes of percutaneous coronary intervention (PCI) and subsequent recovery. Furthermore, patients with uncontrolled or severe comorbidities such as poorly managed hypertension or active systemic infections were excluded due to their potential to significantly affect treatment response and clinical prognosis. Missing data were addressed through real-time data validation and post-collection cross-verification. Cases with incomplete or poor-quality echocardiographic imaging data were excluded from the final analysis. For complication variables, cases with missing key information were excluded. The primary exposure variable was the timing of PCI, categorized as either immediate or delayed. Immediate PCI was defined as a door-to-balloon time of 90 minutes or less, while delayed PCI referred to a duration exceeding 90 minutes. Diabetes mellitus, a key inclusion criterion, was defined as severe hyperglycemia diagnosed before cardiac intervention and meeting at least one of the following: fasting plasma glucose ≥ 7.0 mmol/L or glycated haemoglobin (HbA1c) ≥ 6.5% [6]. The primary outcomes assessed were left ventricular ejection fraction (LVEF), measured via echocardiography both at admission and prior to discharge, and in-hospital mortality. Intra- and post-procedural complications were also evaluated. After obtaining informed consent, data were collected from individuals presenting to the Emergency Department with chest discomfort and requiring PCI for acute STEMI. A structured questionnaire was employed to gather demographic data, clinical presentation, diagnosis details, and procedural information. The questionnaire focused on PCI timing, procedural characteristics, and post-intervention outcomes, including echocardiographic

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findings and any complications. Following data collection, patients were divided into two groups based on PCI timing: immediate and delayed PCI. This stratification enabled a subgroup analysis specifically among diabetic patients with STEMI to examine differences in clinical characteristics and outcomes between the two groups. This structured analysis highlighted the potential impact of PCI timing on the treatment outcomes in diabetic STEMI patients. Sample size was determined using Open Epi software, based on the standard formula for proportion-based studies: $n = Z^2 \times p \times (1-p) / E^2$ [15]. Where Z represents the z-score for a 95% confidence level (1.96), p is the estimated prevalence (26% in this study), and E is the desired margin of error (5%). The calculated minimum sample size was 296 participants. A non-probability convenience sampling technique was employed due to practical constraints, including time limitations, restricted access to a broader patient pool, and the clinical setting. This method allowed for the inclusion of all eligible patients who were readily available during the data collection period. Data analysis was conducted using SPSS version 22.0. Descriptive statistics, including frequencies, percentages, means, and standard deviations, were utilized to summarize demographic and clinical characteristics. The Independent Samples t-test was applied to compare continuous variables (e.g., age) between groups, while the Chi-square test was used for categorical variables. Results were presented in tabular form to effectively illustrate variable distributions and highlight observed patterns through figures.

RESULTS

This study investigated the effect of Percutaneous Coronary Intervention timing on patient outcomes by comparing baseline characteristics, complications, and functional recovery between two groups: patients receiving immediate PCI and those undergoing delayed PCI. The demographic and clinical profiles of the two groups were broadly comparable. The average age of individuals in the immediate PCI group was 55.78 ± 10.85 years, while in the delayed PCI group, it was 55.94 ± 11.92 years (p=0.390). The PCI group that was delayed had a slightly higher ratio of male individuals, 65.7% vs. 60.0%, respectively, with no significant difference, with a p-value of 0.343. Notably, the frequency of hypertension was considerably greater in the delayed PCI group, 71.0% vs. 29.0%, with a significant difference (p<0.05). Other cardiovascular risk factors, including smoking status and diabetes mellitus, were comparable between the two groups (p>0.05) (Table 1).

Table 1: Baseline Characteristics

Variables	Immediate PCI (n=95)	Delayed PCI (n=201)	p-Value
Age and (Mean ± SD, Years)	55.78 ± 10.85	55.94 ± 11.92	0.390
Gender (Male)	57 (60.0%)	132 (65.7%)	0.343
Diabetes Type 1	27 (28.4%)	41 (20.4%)	0.126
Diabetes Type 2	68 (71.6%)	160 (79.6%)	0.126
Hypertension	65 (29.0%)	159 (71.0%)	0.046
Smoking	26 (30.6%)	59 (69.4%)	0.725

Continuous data were presented with mean and SD (±), while categorical data are reported as percentages (%)

The mean ejection fraction (EF) before percutaneous coronary intervention was nearly identical for both groups. The immediate PCI group had an EF of 40.54 ± 6.49 %, while the delayed PCI group recorded an EF of 41.33 ± 7.23 %. There was no discernible change in baseline left ventricular ejection fraction among the two groups (p>0.05). After PCI, both groups experienced improvements in EF. The immediate PCI group achieved an EF of 49.12 ± 7.10 %, while the delayed PCI group reached an EF of 50.85 ± 6.80 %. However, the p-value of 0.114 indicates that the difference in improvement in EF among the two groups was not statistically significant (Table 2).

Table 2: Left Ventricular Function (Functional Recovery)

Variables	Immediate PCI (n=95)	Delayed PCI (n=201)	p-Value
EF Before PCI (Mean ± SD)	40.54 ± 6.49	41.33 ± 7.23	>0.05
EF After PCI (Mean ± SD)	49.12 ± 7.10	50.85 ± 6.80	0.114

The findings illustrate the impact of Percutaneous Coronary Intervention timing on left ventricular ejection fraction (LVEF), comparing immediate versus delayed PCI (Figure 1).

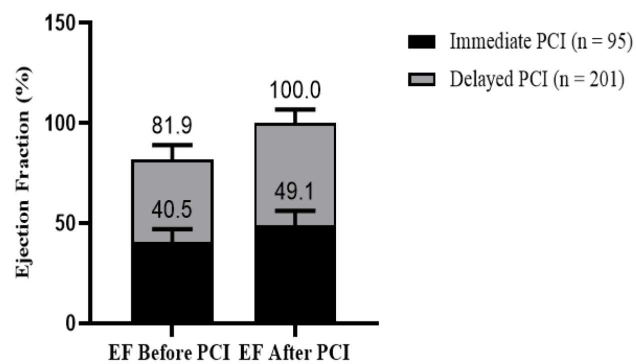

Figure 1: Impact of PCI Timing on Left Ventricular Function
EF=Ejection Fraction, PCI=Percutaneous Coronary Intervention, Continuous data is presented with mean and standard deviation (Mean ± SD%)

The incidence of overall procedural complications was noticeably higher in the Delayed PCI subgroup (64.2%) compared to the Immediate PCI group (35.8%). Specific intra-procedural complications, including ventricular tachycardia, bradycardia, and arterial rupture, occurred

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more frequently in the Delayed PCI subgroup. Nevertheless, none of these comparisons reached statistical significance (p>0.05), indicating a lack of robust evidence supporting a difference among the groups. In terms of post-procedural complications, the rates were comparable in both groups, with each reporting an incidence of 20.1%. However, arrhythmias, heart failure, cardiogenic shock, and myocardial infarction are presented more commonly in the Delayed PCI group. Despite these observations, all P-values were > 0.05, suggesting no statistically significant differences among the groups. There was no reported mortality in either the immediate PCI group or the delayed PCI group (Table 3).

Table 3: Intra and Post-Procedure Complications

Variables	Immediate PCI (n=95)	Delayed PCI (n=201)	p-Value
Intra-Procedure Complications			
Overall Procedural Complications	19 (35.8%)	34 (64.2%)	0.518
Ventricular Tachycardia (VT)	2 (33.3%)	4 (66.7%)	0.739
Tachycardia	12 (41.4%)	17 (58.6%)	0.739
Bradycardia	1 (16.7%)	5 (83.3%)	0.739
Artery Rupture	3 (42.9%)	4 (57.1%)	0.739
Post-Procedure Complications			
Overall Post-Procedural Complications	16 (20.1%)	39 (20.1%)	0.597
Arrhythmia	2 (11.8%)	15 (88.2%)	0.227
Heart Failure	2 (25.0%)	6 (75.0%)	0.227
Cardiogenic Shock	3 (33.3%)	6 (66.7%)	0.227
Myocardial Infarction	7 (38.9%)	11 (61.1%)	0.227

Categorical data are reported as a percentage (%)

DISCUSSIONS

Despite advancements in primary percutaneous coronary intervention (PCI), the optimal timing of intervention for patients with ST-segment elevation myocardial infarction (STEMI), particularly in those with diabetes mellitus, remains a subject of ongoing debate. So the study evaluated the impact of PCI timing on outcomes by comparing baseline characteristics, complication rates, and recovery between immediate and delayed PCI groups. Baseline demographics, including mean age (55.78 ± 10.85 vs. 55.94 ± 11.92 years; p=0.390), were similar across groups, consistent with findings from a tertiary care hospital in South Punjab (mean age 53.51 ± 11.37) [16]. No significant differences were observed in intra-procedure complications (p=0.597), post-PCI recovery (p=0.114), or the incidence of complications such as arrhythmia, heart failure, and cardiogenic shock. Our findings align with the Korea Acute Myocardial Infarction Registry, which showed no increased long-term mortality in late presenters, despite higher in-hospital deaths (p=0.006). However, it contrasts with another report from the same registry showing significantly worse 180-day outcomes in late presenters (10.7% vs. 6.8%, p<0.001) [17]. Similarly, a Chinese study comparing early (3–14 days) vs. late (>14 days) PCI also reported no significant differences in major adverse events or strokes [13]. Contrasting results were observed in an Israeli retrospective study (2000–2021), where late presenters (>48 hours) experienced higher 30-day adverse cardiovascular events [18]. Supporting our findings, studies from GMCT Cardiology and Dr Kariadi General Hospital found no significant differences in major complications or myocardial recovery between early and late interventions [19, 20]. A systematic review further supports our results, finding no significant differences between immediate and delayed PCI regarding bleeding, re-intervention, mortality, ejection fraction, or major events in STEMI patients [21]. While the NHR study reported worse PCI outcomes in diabetics [8], the study found no significant association between diabetes and patient outcomes. Our findings contrast with studies from Iran and Denmark, which found delays associated with reduced LVEF and increased MI or heart failure risk, respectively [22, 23]. Similarly, a Kerala-based prospective study reported higher 1-year adverse events with delayed PCI [24], and a Multan-based study showed a significant correlation between early presentation and better EF (p=0.0001) [24]. However, our data revealed no such association between PCI timing and EF. Several limitations must be acknowledged. First, the cross-sectional design precludes causal inference and limits our ability to assess long-term outcomes. Second, our sample was derived using convenience sampling from a single tertiary care centre, which may limit generalizability. Additionally, certain confounding variables, such as glycemic control levels, symptom-onset-to-balloon time, and pre-hospital delays, were not fully controlled, potentially influencing the results. Finally, echocardiographic assessments, although standardized, may vary based on operator interpretation, affecting LVEF measurements.

CONCLUSIONS

Timely PCI in diabetic STEMI patients influences recovery outcomes. While delayed PCI showed slightly better improvement in left ventricular function, it did not significantly differ from immediate PCI in terms of complications or overall functional recovery. These findings suggest that PCI timing alone may not critically alter short-term clinical outcomes in this high-risk group, supporting a more individualized treatment approach.

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Authors Contribution

Conceptualization: BA
Methodology: MU, HU, BA, MA
Formal analysis: BA
Writing review and editing: SG, SS

All authors have read and agreed to the published version of the manuscript

Conflicts of Interest

All the authors declare no conflict of interest.

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