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IMPACT OF TIME DELAY ON SHORT TERM OUTCOMES OF PRIMARY PERCUTANEOUS CORONARY INTERVENTION (PCI) IN PAKISTANI POPULATION

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ABSTRACT:

INTRODUCTION: *Globally, acute myocardial infarction (AMI), especially ST-elevation myocardial infarction (STEMI), continues to be a major source of morbidity and mortality, making timely and efficient interventions imperative. Primary percutaneous coronary intervention (PCI) has emerged as the gold standard for reperfusion therapy, significantly reducing adverse outcomes when administered within optimal timeframes. However, in resource-limited settings such as Pakistan, delayed intervention often undermines its potential benefits, posing a critical challenge for healthcare providers.*

AIMS & OBJECTIVE: *To evaluate the impact of time delay on short-term outcomes of primary percutaneous coronary intervention in the Pakistani population, focusing on patients treated at Hayatabad Medical Complex, Peshawar.*

MATERIAL & METHODS: *A retrospective analysis was conducted on 322 STEMI patients treated between January and December 2023. Patients were divided into "On-Time PCI" (<90 minutes, n=161) and "Delayed PCI" (>90 minutes, n=161) groups. Data on LV function, MACE, mortality, and total ischemic time were collected and analyzed using t-tests, chi-square tests, and multivariate regression.*

RESULTS: *The "On-Time PCI" group had a considerably higher mean LV function (55.1 ± 4.8%) than the "Delayed PCI" group (44.8 ± 6.3%, $p < 0.001$). The "On-Time PCI" group had a lower MACE incidence (6.8%) than the "Delayed PCI" group (27.3%, $p < 0.001$). Mortality rates were 2.5% in the "On-Time PCI" group and 9.3% in the "Delayed PCI" group ($p = 0.004$). Multivariate regression identified delayed PCI as a predictor of lower LV function (coefficient = -9.8, $p < 0.001$), higher MACE (odds ratio = 4.5, $p < 0.001$), and increased mortality (odds ratio = 3.2, $p = 0.02$).*

CONCLUSION: *Delayed PCI timing significantly worsens outcomes in STEMI patients, emphasizing the need for timely intervention. Strategies to reduce delays are critical for improving myocardial recovery and survival.*

KEY WORDS: *STEMI, PCI, ischemic time, MACE, myocardial recovery.*

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INTRODUCTION:

Globally, acute myocardial infarction (AMI), especially ST-elevation myocardial infarction (STEMI), continues to be a major source of morbidity and mortality, making timely and efficient interventions imperative. Primary percutaneous coronary intervention (PCI) has emerged as the gold standard for reperfusion therapy, significantly reducing adverse outcomes when administered within optimal timeframes.[1] However, in resource-limited settings such as Pakistan, delayed intervention often undermines its potential benefits, posing a critical challenge for healthcare providers.[2]

Recent studies in Pakistan have underscored the efficacy of PCI in improving short-term survival and left ventricular function, particularly when implemented within the recommended time window.[3] Despite this, the median symptom-to-device times often exceed international benchmarks, reflecting systemic delays and low public awareness.[4]

In Hayatabad Medical Complex, Peshawar, where this study is based, PCI services cater to a diverse demographic, many of whom present with delayed symptoms owing to geographical and infrastructural barriers. These delays correlate strongly with increased mortality and major adverse cardiac events (MACE) within the short-term postoperative period.[5] The necessity for immediate therapy is further highlighted by studies indicating that individuals with longer total ischemia times recover from localized wall motion anomalies less quickly.[6]

The detrimental impact of prolonged ischemic times, as evident in studies from South Punjab and Karachi, necessitates tailored strategies for improving time-to-treatment metrics. Patients presenting directly to PCI-capable centers often demonstrate markedly better outcomes than those transferred from non-PCI facilities.[7] This is consistent with findings from similar studies showing that patients transferred from non-PCI facilities experience longer delays and worse outcomes.[8]

Globally, evidence reinforces the significance of minimizing door-to-balloon times to enhance post-PCI recovery. International data, including those from Norway, confirm that pre-hospital delay is an independent predictor of mortality in STEMI patients.[9] Similarly, the time from first medical contact to device deployment has been identified as a crucial factor influencing short-term outcomes.[10] Nevertheless, replicating these findings in the Pakistani context, characterized by limited resources and healthcare disparities, remains a pressing need.[11]

This study aims to bridge the gap in understanding how time delays affect PCI outcomes specifically in the Pakistani population. By investigating short-term outcomes at Hayatabad Medical Complex, we aim to identify actionable insights to reduce ischemic times and improve survival rates. Our findings could inform policies that prioritize timely interventions and resource allocation in similar settings.
This study aimed to evaluate the impact of delayed primary PCI on short-term outcomes, including left ventricular (LV) function, MACE, and mortality, in STEMI patients at Hayatabad Medical Complex, Peshawar.

MATERIAL AND METHODS:

Study Design and Setting

Over the course of 12 months, from January 2023 to December 2023, this retrospective study was carried out at the Department of Cardiology, Hayatabad Medical Complex, Peshawar.

Sample Size

The sample size was calculated using

the WHO sample size calculator. Based on a related study by Shah et al. (2023), which reported a 30% incidence of MACE in patients experiencing delayed PCI, with a margin of error set at 5% and a confidence level of 95%, the calculated sample size was 322 patients.These patients were divided into two groups: those receiving PCI within the recommended time frame (<90 minutes, n=161) and those experiencing delayed PCI (>90 minutes, n=161).

INCLUSION AND EXCLUSION CRITERIA:

The study included adults aged 18 years and older who presented with STEMI and underwent primary PCI within 12 hours of symptom onset. Exclusion criteria included patients with contraindications to PCI, those presenting more than 12 hours after symptom onset, individuals with a history of coronary artery bypass graft surgery, and those who did not provide consent to participate. Patients with incomplete medical records were also excluded to maintain data integrity.

DATA COLLECTION PROCEDURE:

Data were collected from electronic medical records and patient charts. Information on demographics, clinical presentation, ischemic times (symptom-to-door and door-to-balloon), procedural details, and short-term outcomes (MACE, mortality, revascularization) was extracted. Data accuracy was ensured through double entry and cross-verification by two independent reviewers.

Definitions and Assessment Criteria

• Time Delay: Defined as the total time from symptom onset to balloon inflation during PCI. Delays were categorized as acceptable (<90 minutes) or delayed (>90 minutes), based on international guidelines.

• MACE: Included mortality, recurrent myocardial infarction, target vessel revascularization, and stroke occurring within 30 days post-PCI.

• Outcomes: Primary outcome was the incidence of MACE, while secondary outcomes included in-hospital mortality and left ventricular function recovery assessed via echocardiography.

STATISTICAL ANALYSIS:

Statistical software was utilized for data analysis. Continuous variables were presented as mean ± standard deviation, while categorical variables were reported as frequencies and percentages. Comparisons between groups were conducted utilizing suitable statistical tests, with a significance threshold set at a p-value of less than 0.05. Multivariate regression analysis was conducted to identify independent predictors of adverse outcomes.

Continuous variables were analyzed using t-tests, while chi-square tests were used for categorical outcomes such as MACE and mortality. Multivariate regression models identified independent predictors of adverse outcomes, confirming the role of delayed PCI timing as a key determinant.

ETHICAL CONSIDERATIONS:

The research was carried out in accordance with the Declaration of Helsinki. Approval was secured from the Ethical and Research Committee at Hayatabad Medical Complex, Peshawar. Informed consent was waived because of the study's retrospective design; however, patient confidentiality and anonymity were rigorously upheld throughout the research.

RESULTS:

Overview and Patient Count

The study had 322 patients, equally allocated into two groups according to PCI timing: 161 patients in the "On-Time PCI" group and 161 in the "Delayed PCI" group. The analysis focused on differences in LV function, MACE, ischemic time, and associated variables.

Baseline Characteristics

The baseline demographic and clinical characteristics were comparable between the two groups. The mean age was 56.3 years (SD: 9.2), with a male predominance of 68%. Hypertension was prevalent in 45% of the patients, and diabetes mellitus was recorded in 38%. Smoking history was more common in males, with no significant difference between the groups ($p > 0.05$). (Table-1)

LV Function and PCI Timing

Table 2 compares the mean LV function between groups. Patients in the "On-Time PCI" group demonstrated significantly better LV function (mean: 55.1%, SD: 4.8) compared to the "Delayed PCI" group (mean: 44.8%, SD: 6.3). A t-test revealed

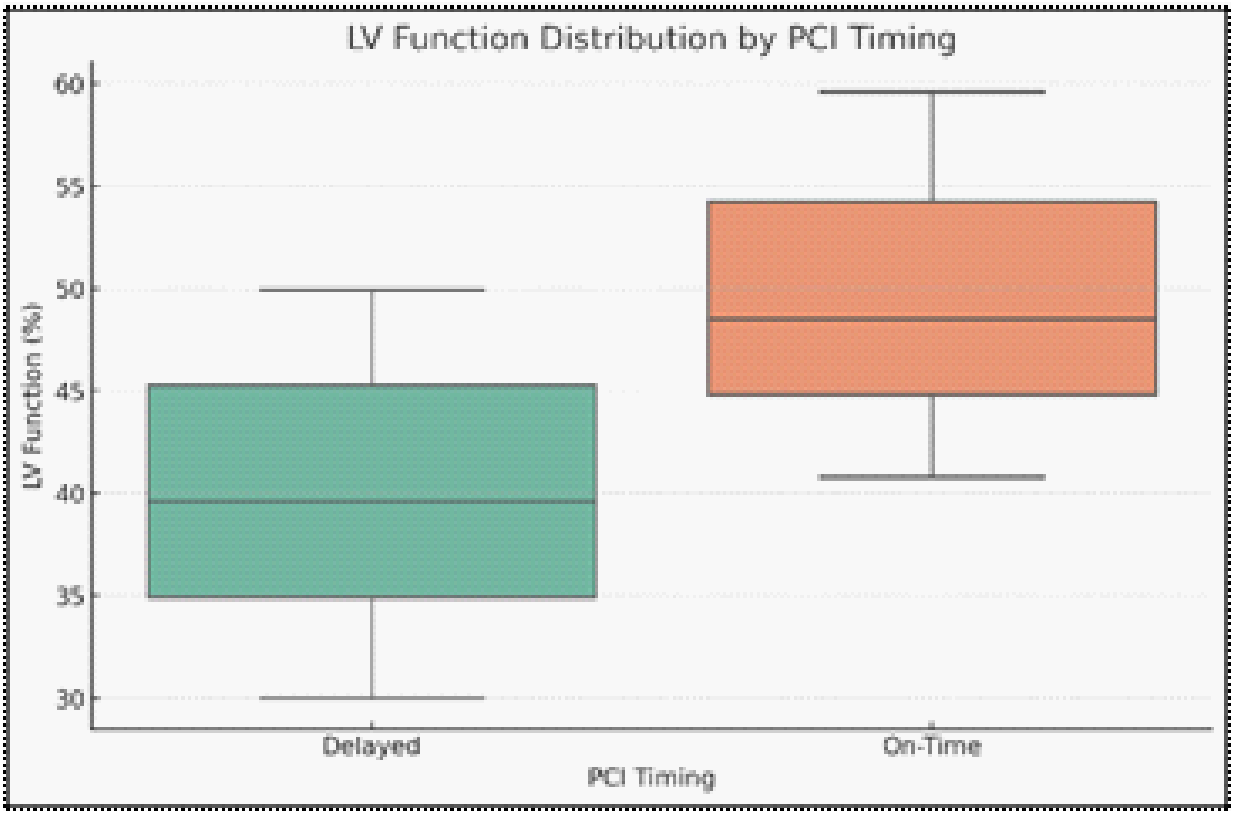

Figure 1: LV Function Distribution by PCI Timing

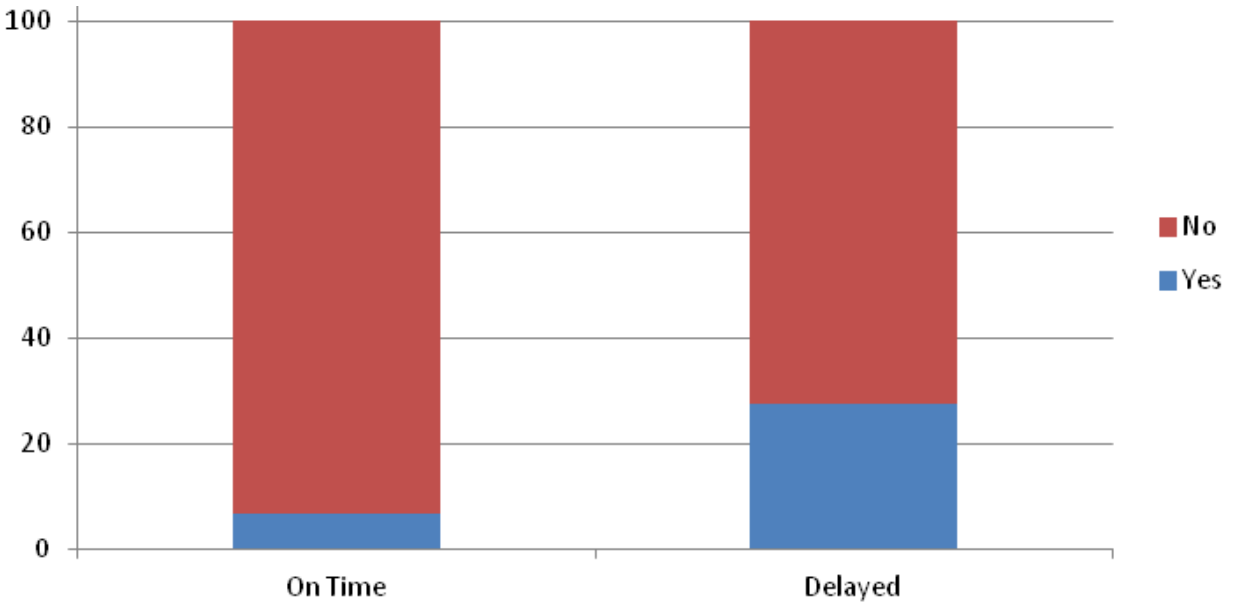

Figure 2: Proportion of MACE by PCI Timing

Table 1 provides a summary of the baseline characteristics			
Characteristic	**On-Time PCI**	**Delayed PCI**	**p-value**
Age (years, mean ± SD)	55.9 ± 8.8	56.7 ± 9.5	0.42
Male (%)	69	67	0.62
Hypertension (%)	44	46	0.78
Diabetes Mellitus (%)	37	39	0.7
Smoking History (%)	36	34	0.65

Table 2 Mean LV Function by PCI Timing			
Group	**Mean (%)**	**Standard Deviation**	**p-value**
On-Time PCI (n=161)	55.1	4.8	<0.001
Delayed PCI (n=161)	44.8	6.3	

Table 3 MACE Incidence by PCI Timing			
PCI Timing	**MACE (%)**	**Non-MACE (%)**	**p-value**
On-Time PCI	6.8	93.2	<0.001
Delayed PCI	27.3	72.7	

Table 4 Predictors of Adverse Outcomes in dely PCI.		
Outcome	**Coefficient/Odds Ratio**	**p-value**
Lower LV Function	-9.8	<0.001
Higher MACE Incidence	4.5	<0.001
Increased Mortality	3.2	0.02

a significant difference ($p < 0.001$). Figure 1 shows the distribution of LV function between the groups, highlighting the substantial impact of timely PCI on myocardial recovery.

MACE Incidence and PCI Timing

The incidence of MACE was significantly higher in the "Delayed PCI" group (27.3%) compared to the "On-Time PCI" group (6.8%), as shown in Table 3. A chi-square test confirmed a strong association between PCI timing and MACE ($p < 0.001$). Figure 2 illustrates the proportional distribution of MACE by PCI timing. The higher rates in the "Delayed PCI" group emphasize the adverse outcomes of prolonged ischemic times.

Ischemic Time and Mortality

The total ischemic time, which is the duration from symptom onset to balloon inflation, was notably extended in the "Delayed PCI" group. The delay correlated with elevated in-hospital mortality rates (9.3% vs. 2.5%, $p = 0.004$) and higher revascularization rates (15.5% vs. 5.6%, $p < 0.001$) when compared to the "On-Time PCI" group.

Predictors of Adverse Outcomes

Multivariate regression analysis revealed that delayed PCI timing significantly predicted adverse outcomes. It was associated with a decrease in LV function (coefficient = -9.8, $p < 0.001$), higher MACE incidence (odds ratio = 4.5, $p < 0.001$), and increased mortality (odds ratio = 3.2, $p = 0.02$). These results highlight the critical impact of procedural delays on myocardial recovery and overall patient survival. (Table-4)

DISCUSSION:

This study highlights the significant impact of delayed PCI timing on clinical outcomes in patients with STEMI. Delayed PCI was associated with lower LV function, higher incidence of MACE, and increased mortality. These findings emphasize the importance of timely intervention in improving myocardial recovery and patient survival.

The originality of this study lies in its focus on the Pakistani population, particularly at Hayatabad Medical Complex, Peshawar, where such a comprehensive analysis of PCI timing and outcomes has not been conducted before. Previous studies in Pakistan have reported general outcomes of PCI without delving deeply into the timing of intervention. For example, Shahzad et al. (2021) highlighted the overall success of PCI in reducing adverse events but did not specifically examine the effect of time delays.7 Similar studies in Karachi and Lahore reported the efficacy of PCI but lacked a focused analysis of ischemic times.[2]

Globally, evidence supports the detrimental impact of prolonged ischemic times on cardiac outcomes. Studies from Norway and the United States have demonstrated that PCI delays increase the likelihood of mortality and adverse cardiac events.[9] A meta-analysis by Wenner et al. (2020) further corroborates that reducing total ischemic time can significantly enhance survival rates and myocardial recovery.[10]

Despite robust international literature, there is limited data from Pakistan addressing the effects of PCI timing. Most local studies focus on procedural success rates without considering time delays.[7] However, delayed presentations are more common in Pakistan due to factors like limited healthcare access, lack of awareness, and infrastructural barriers. This study is among the first to systematically evaluate these factors in the Pakistani population.

The findings align with previous research, which indicates that delayed PCI leads to significant reductions in LV function. International studies by Rathod et al. (2020) have similarly reported worse outcomes in patients transferred from non-PCI-capable centers.[8] In Pakistan, logistical delays are a critical barrier, highlighting the need for streamlined healthcare pathways to reduce ischemic times.

This study underscores the necessity of timely PCI to optimize patient outcomes. The significantly lower LV function and higher MACE incidence in the "Delayed PCI" group reflect the irreversible myocardial damage caused by prolonged ischemic times. These results reinforce the global guidelines advocating for door-to-balloon times of less than 90 minutes.

There is prognostic implication of time delay in patients with STEMI undergoing primary PCI.[12] In STEMI patients, any delay in treatment increased their risk of MACE.[13] PCI in late-presenting STEMI patients without prior thrombolysis yields favorable short-term outcomes, characterized by a high procedural success rate and manageable complication rates.[14]

STUDY LIMITATIONS AND FUTURE DIRECTIONS:

This study has certain limitations. The retrospective design may introduce biases related to data collection and analysis. The study was conducted at a single center, potentially limiting the generalizability of the findings to other regions of Pakistan. Future research should focus on multi-center studies to capture a more comprehensive dataset and assess strategies to reduce delays in PCI. Interventional studies exploring the role of public health campaigns and streamlined healthcare pathways could further enhance understanding and address systemic barriers.

CONCLUSION:

This study highlights the critical impact of delayed PCI timing on clinical outcomes in STEMI patients, demonstrating that prolonged ischemic times are associated

with significantly lower LV function, higher MACE incidence, and increased mortality. These findings align with the study objectives, emphasizing the necessity for timely intervention to optimize myocardial recovery and survival. The results underscore the importance of adhering to recommended door-to-balloon times and addressing systemic barriers that contribute to delays in PCI. In Pakistan, where healthcare access and awareness remain significant challenges, targeted strategies such as streamlined referral systems, enhanced emergency response protocols, and public education campaigns are essential.

Future Recommendations: Further multi-center studies should be conducted to validate these findings across diverse populations. Efforts should focus on improving healthcare infrastructure and public awareness to reduce delays and enhance outcomes for STEMI patients nationwide.

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