

Original Article

# Impact of Total Ischemic Time on Clinical Outcome in STEMI Patients Undergoing Percutaneous Coronary Intervention

Tariq Nawaz<sup>1</sup>, Hassan Ali<sup>2\*</sup>, Sadam Hussain<sup>2</sup>, Wasim Sajjad<sup>3</sup>, Muhammad Amin<sup>2</sup>

<sup>1</sup>Assistant Professor Cardiology, Lady Reading Hospital, Peshawar, Pakistan.

<sup>2</sup>PGR Cardiology, Lady Reading Hospital Peshawar, Pakistan.

<sup>3</sup>Fellow Interventional Cardiology, Lady Reading Hospital Peshawar, Pakistan.

\*Corresponding Author: Hassan Ali, PGR Cardiology; Email: hussey811@yahoo.com

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## ABSTRACT

**Background:** ST-segment elevation myocardial infarction (STEMI) represents a critical condition requiring prompt treatment to minimize myocardial damage. Percutaneous coronary intervention (PCI) is the preferred reperfusion strategy, with the total ischemic time (TIT) being a crucial determinant of clinical outcomes. Despite the recognized importance of minimizing door-to-balloon (DTB) time, the impact of TIT on STEMI outcomes necessitates further exploration.

**Objective:** This study aimed to evaluate the association between TIT and clinical outcomes in STEMI patients undergoing PCI, specifically focusing on all-cause mortality, re-hospitalization, and revascularization rates.

**Methods:** A descriptive study was conducted at the cardiology ward of Lady Reading Hospital from May 2023 to October 2023. Ninety patients diagnosed with STEMI and undergoing PCI were enrolled. Patients were excluded if they had a history of cardiac surgeries or a DTB time >90 minutes. TIT was categorized into ≤120 minutes (Group A) and >120 minutes (Group B). Clinical outcomes assessed at 6 months post-PCI included all-cause mortality, cardiac mortality, re-hospitalization, and revascularization. Data were analyzed using SPSS version 25, employing Chi-Square tests for categorical variables, with a p-value ≤ 0.05 considered statistically significant.

**Results:** Among the participants, Group A (TIT ≤ 120 mins) comprised 33 patients, while Group B (TIT > 120 mins) included 57 patients. Increased TIT was associated with higher rates of all-cause mortality (21.1% in Group B vs. 6.1% in Group A, p=0.05), re-hospitalization (22.8% vs. 6.1%, p=0.04), and revascularization (29.8% vs. 12.1%, p=0.05). Cardiac mortality was also higher in Group B (10.5%) compared to Group A (3.0%), though this difference was not statistically significant (p=0.20).

**Conclusion:** The study highlights the significant impact of TIT on the prognosis of STEMI patients undergoing PCI. Shorter TIT is associated with markedly better clinical outcomes, emphasizing the need for healthcare systems to adopt strategies that reduce both pre-hospital and in-hospital delays.

**Keywords:** ST-segment elevation, myocardial infarction, percutaneous coronary intervention, total ischemic time, clinical outcomes, all-cause mortality, re-hospitalization, revascularization.

## INTRODUCTION

Myocardial infarction (MI), commonly referred to as a heart attack, emerges when the blood supply to a portion of the myocardium is reduced or halted, leading to a wide range of clinical manifestations from asymptomatic conditions to severe episodes that significantly impair heart function and can result in premature death (1). The genesis of myocardial infarction is primarily linked to pre-existing coronary artery disease, where obstruction in the coronary artery leads to myocardial oxygen deprivation (2,3). The prolonged absence of oxygen can eventually cause death and necrosis of cardiac cells (4,5), underscoring the critical nature of timely medical intervention. In the management of ST-segment elevation myocardial infarction (STEMI), percutaneous coronary intervention (PCI) is identified as the optimal method for restoring blood flow, provided it is performed swiftly and by skilled practitioners. The duration from patient's hospital arrival to the performance of balloon angioplasty, globally recognized as a vital indicator of care quality in STEMI treatment, has been the focus of significant attention (6-8). Recent strategies aimed at optimizing STEMI care have prioritized the reduction of the door-to-balloon (D2B) time (9). However, this approach neglects the considerable

mortality associated with STEMI that occurs before hospital admission. Moreover, it has been suggested that decreasing D2B time may not confer additional benefits for patients who are admitted to the hospital well after symptom onset (10-12). As such, initiatives directed at shortening D2B time have not consistently demonstrated a reduction in mortality rates for STEMI patients (13). This discrepancy highlights the importance of extending STEMI management efforts beyond the reduction of D2B time, to encompass enhancements in both pre-hospital and in-hospital care.

As healthcare systems evolve, the imperative to develop strategies that reduce total ischemic time (TIT) becomes increasingly clear, with the aim of providing efficient and effective treatment to patients confronted with this serious cardiac event. The purpose of this study is to assess the impact of TIT on clinical outcomes in STEMI patients undergoing PCI, integrating existing research, analyzing contributing factors, and acknowledging advancements in the continuum of care.

## MATERIAL AND METHODS

This descriptive research was undertaken in the cardiology ward of Lady Reading Hospital, spanning from May to October 2023, following the receipt of ethical approval from the hospital's ethics committee. The study aimed to investigate clinical outcomes in ST-segment elevation myocardial infarction (STEMI) patients undergoing percutaneous coronary intervention (PCI). A cohort of 90 patients who experienced STEMI and subsequently underwent PCI was meticulously selected. Eligibility criteria included individuals aged 18 years and older, of any gender, who expressed consent to participate in the study. Exclusion criteria were set to omit patients with a history of previous cardiac surgeries or those who had a door-to-balloon time exceeding 90 minutes, ensuring the homogeneity and relevance of the study population.

Patients were stratified based on the total ischemic time (TIT), with divisions made at the threshold of  $\leq 120$  minutes and  $> 120$  minutes. The categorization facilitated a comparative analysis of clinical outcomes, which were meticulously documented on pre-designed pro-formas. Outcomes of interest included all-cause mortality, cardiac mortality, re-hospitalization, and revascularization rates, providing a comprehensive overview of patient trajectories post-PCI. All procedures were conducted under the aegis of an experienced consultant cardiologist, boasting over five years of expertise in the field, thereby ensuring a high standard of care throughout the study.

Data collection was rigorously conducted, with all relevant information and outcomes recorded systematically. The assessment of patients was carried out at a 6-month follow-up mark post-procedure, offering insights into the long-term impact of TIT on clinical outcomes. Ethical considerations were paramount, with the study adhering to the Declaration of Helsinki principles for medical research involving human subjects, ensuring the rights, safety, and well-being of participants were protected.

For the analysis of the amassed data, SPSS version 25 was employed, signifying an update to the most current statistical software available at the time of the study. The Chi-Square test was utilized for evaluating associations between categorical variables, with a p-value of  $\leq 0.05$  designated as the threshold for statistical significance. This methodological approach underscored the study's commitment to rigor and precision in elucidating the impact of TIT on the clinical outcomes of STEMI patients post-PCI.

## RESULTS

In the study conducted to assess the impact of Total Ischemic Time (TIT) on clinical outcomes in patients with ST-segment elevation myocardial infarction (STEMI) undergoing percutaneous coronary intervention (PCI), demographic characteristics and clinical outcomes were meticulously recorded and analyzed. The demographic distribution of the study population was divided into two groups based on the TIT: Group A with TIT  $\leq 120$  minutes and Group B with TIT  $> 120$  minutes.

The gender distribution within these groups revealed a predominance of male patients, with Group A comprising 26 males (78.8%) and 7 females (21.2%), while Group B included 43 males (75.4%) and 14 females (24.6%) (Table 1). This gender distribution underscores the higher incidence of STEMI in males within the study cohort. Regarding comorbid conditions, diabetes was present in 14 patients (42.4%) in Group A and 21 patients (36.8%) in Group B, indicating a slightly higher prevalence of diabetes in the group with shorter ischemic time. Conversely, 19 patients (57.6%) in Group A and 36 patients (63.2%) in Group B did not have diabetes, reflecting a notable portion of the study population without this comorbidity.

Hypertension was another factor examined, with 15 patients (45.5%) in Group A and 27 patients (47.4%) in Group B diagnosed with this condition, suggesting a fairly consistent prevalence across both TIT groups. The smoking status of participants also provided interesting insights; a significantly higher proportion of smokers was observed in Group A (22 patients, 66.7%) compared to Group B (21 patients, 36.8%), illustrating a potential correlation between smoking and shorter TIT in STEMI patients (Table 1).

The KILLIP class, used to categorize the severity of heart failure, showed that the majority of patients in both groups were classified as Class I (28 patients, 84.8% in Group A and 51 patients, 89.5% in Group B), indicating a predominance of patients with no signs of heart failure upon presentation (Table 1).

Table 1: Demographic Characteristics of Patients by Total Ischemic Time (TIT) Groups

Demographic Factor	Group A (TIT ≤ 120 mins)		Group B (TIT > 120 mins)	
	N	%	N	%
<b>Gender</b>				
Male	26	78.8%	43	75.4%
Female	7	21.2%	14	24.6%
<b>Diabetes</b>				
Yes	14	42.4%	21	36.8%
No	19	57.6%	36	63.2%
<b>Hypertension</b>				
Yes	15	45.5%	27	47.4%
No	18	54.5%	30	52.6%
<b>Smoking</b>				
Yes	22	66.7%	21	36.8%
No	11	33.3%	36	63.2%
<b>KILLIP Class</b>				
I	28	84.8%	51	89.5%
II	2	6.1%	3	5.3%
III	1	3.0%	2	3.5%
IV	2	6.1%	1	1.8%

Table 2: Clinical Outcomes at 6-Month Follow-Up by TIT Groups

Outcome	Group A (TIT ≤ 120 mins)		Group B (TIT > 120 mins)		P value
	N	%	N	%	
<b>All-cause Mortality</b>					
Yes	2	6.1%	12	21.1%	0.05
No	31	93.9%	45	78.9%	
<b>Cardiac Mortality</b>					
Yes	1	3.0%	6	10.5%	0.20
No	32	97.0%	51	89.5%	
<b>Re-hospitalization</b>					
Yes	2	6.1%	13	22.8%	0.04
No	31	93.9%	44	77.2%	
<b>Revascularization</b>					
Yes	4	12.1%	17	29.8%	0.05
No	29	87.9%	40	70.2%	

Clinical outcomes at the 6-month follow-up highlighted significant differences between the two groups (Table 2). All-cause mortality was notably higher in Group B (12 patients, 21.1%) compared to Group A (2 patients, 6.1%), with a P value of 0.05, suggesting a trend towards increased mortality with longer TIT. Similarly, cardiac mortality was higher in Group B (6 patients, 10.5%) as opposed to Group A (1 patient, 3.0%), though the difference did not reach statistical significance (P value = 0.20).

Re-hospitalization rates were significantly different, with Group B experiencing a higher rate (13 patients, 22.8%) compared to Group A (2 patients, 6.1%), indicated by a P value of 0.04. This suggests that patients with longer TIT are more likely to be re-hospitalized. The need for revascularization followed a similar pattern, where Group B had a higher proportion of patients requiring this intervention (17 patients, 29.8%) compared to Group A (4 patients, 12.1%), with a P value of 0.05, highlighting the potential impact of prolonged ischemic time on the necessity for further revascularization procedures.

## DISCUSSION

In the realm of acute coronary syndromes, timely reperfusion therapy is paramount for mitigating myocardial damage following ST-segment elevation myocardial infarction (STEMI). The efficacy of reperfusion treatments, notably percutaneous coronary intervention (PCI), is profoundly time-sensitive, peaking during the initial hours post-onset of chest discomfort and diminishing with

each subsequent hour (13). Given its capacity to promptly re-establish coronary artery patency, PCI is preferred over pharmacological strategies for reperfusion in STEMI patients. Consequently, the duration from emergency department arrival to the commencement of balloon inflation—a period often referred to as door-to-balloon (DTB) time—has emerged as a critical quality indicator for PCI, with management guidelines for STEMI advocating for a maximum DTB time of 90 minutes (14).

Despite the significant emphasis on reducing DTB time, other temporal factors in the STEMI care continuum, such as the interval between the onset of chest pain and hospital arrival at a PCI-capable facility, have garnered less attention. Total ischemic time (TIT), encompassing the period from symptom onset to balloon inflation or device activation, arguably presents a more comprehensive prognostic indicator, as prolonged ischemia correlates with an expanded area of microvascular obstruction (15).

Our investigation into the impact of TIT on clinical outcomes in 90 STEMI patients undergoing PCI sought to bridge this gap in research. Patients were stratified based on TIT—with a threshold of 120 minutes—revealing that an extended TIT (>120 minutes) significantly correlated with increased all-cause mortality, re-hospitalization, and revascularization rates compared to a TIT ≤ 120 minutes. Notably, the group with an extended TIT experienced a higher incidence of cardiac mortality, with six instances, versus only one within the shorter TIT cohort. This observation aligns with another study that identified a considerable proportion (34.2%) of STEMI patients presenting with a prolonged TIT (>240 minutes) (18), further underscoring the adverse outcomes associated with delayed treatment.

Contrasting with the singular focus on DTB time, our findings are consistent with previous research indicating that reductions in DTB time do not necessarily translate into improved outcomes for patients presenting late after symptom onset. Factors contributing to prolonged TIT include patients' inability to recognize cardiac symptoms, lack of immediate access to medical care, transportation issues, financial constraints, and geographical barriers to PCI facilities (16,17). These elements underscore the multifaceted challenges in optimizing STEMI care and highlight the necessity for comprehensive strategies that address both pre-hospital and in-hospital delays.

The study's strength lies in its focused examination of TIT as a determinant of clinical outcomes in STEMI patients, offering insights that can inform future interventions aimed at reducing ischemic time. However, its limitations include the relatively small sample size and the single-center design, which may restrict the generalizability of the findings. Additionally, the study did not account for variations in pre-hospital care or the severity of coronary artery disease, which could influence clinical outcomes (18, 19).

In light of these findings, we advocate for a broader approach to STEMI management that encompasses both the reduction of DTB time and the minimization of pre-hospital delays (20). Further research is warranted to explore the benefits of shortened TIT across diverse healthcare settings and populations. Such studies should aim to identify effective interventions that can mitigate the barriers to timely PCI, ultimately enhancing the prognosis for patients presenting with STEMI.

## CONCLUSION

The study conclusively demonstrates that shorter total ischemic time (TIT) significantly correlates with improved clinical outcomes, including reduced all-cause mortality, re-hospitalization, and revascularization rates in patients with ST-segment elevation myocardial infarction (STEMI) undergoing percutaneous coronary intervention (PCI). These findings underscore the imperative for healthcare systems to not only focus on minimizing door-to-balloon (DTB) time but also to address pre-hospital delays through enhanced public awareness, streamlined emergency response protocols, and broader access to PCI-capable facilities. By adopting a holistic approach that targets both components of TIT, healthcare providers can better optimize treatment timelines, ultimately improving survival rates and quality of life for STEMI patients.

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