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Original Article

Factors Influencing Post-Thrombolytic ST-Segment Resolution in STEMI Patients: A Cross-Sectional Study from Tertiary Care Hospitals

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Abstract

Objectives: This study aimed to evaluate the effectiveness of post-thrombolytic ST-segment resolution in patients with ST-elevation myocardial infarction (STEMI) and to identify factors associated with the resolution outcomes.

Methodology: A cross-sectional study was conducted at Mardan Medical Complex and Bacha Khan Medical Complex Swabi. Electrocardiogram (ECG) of STEMI patients were reviewed to assess the resolution of ST-segment elevation after thrombolytic therapy. Complete resolution was defined as a ≥70% reduction in ST-segment elevation, partial resolution as a reduction between 30% and 70%, and failed resolution as a <30% reduction. Data were entered and analyzed using SPSS.

Results: A total of 222 STEMI patients were included in the study, with 61.3% being male. The mean age of the participants was 57.9±10.8 years. After thrombolytic therapy, 27.5% of patients achieved complete ST-segment resolution, while 51.8% had partial resolution. The resolution of ST-segment elevation was significantly associated with a history of hypertension, but no significant association was found with diabetes mellitus, dyslipidemia, or renal disease.

Conclusion: The rate of complete ST-segment resolution following thrombolytic therapy in STEMI patients was relatively low compared to partial resolution. Hypertension was significantly associated with the degree of ST-segment resolution, while diabetes mellitus, dyslipidemia, and renal disease did not significantly impact the resolution of ST-segment elevation in STEMI patients.

Keywords: Myocardial infarction, ST elevation, Streptokinase, ST resolution, Hypertension, Thrombolytic therapy

INTRODUCTION

Coronary artery disease (CAD) is a leading cause of cardiovascular diseases (CVDs), characterized by a reduction in blood and oxygen supply to the myocardium, resulting in ischemic damage to the heart muscle. The severity of CAD can manifest in various forms of acute coronary syndrome (ACS), including unstable angina, non-ST-segment elevation myocardial infarction (NSTEMI), and ST-segment elevation myocardial infarction (STEMI). In Pakistan, CAD is a growing concern, with STEMI accounting for approximately 56% of all myocardial infarctions (MIs), highlighting the significant burden of cardiovascular disease in the region [1].

The extent of myocardial injury and infarct size in STEMI patients is primarily determined by the duration of ischemia, with longer ischemic times leading to more extensive cellular death [2]. STEMI is typically diagnosed using a 12-lead electrocardiogram (ECG), which reveals characteristic ST-segment elevation [3,4]. The most common pathophysiological cause of STEMI is intracoronary thrombosis, which often occurs after plaque rupture or erosion, leading to partial or complete blockage of the affected coronary artery [5].

For the treatment of STEMI, primary percutaneous coronary intervention (PPCI) is the gold standard and widely regarded as the most effective reperfusion strategy. However, in resource-limited settings or situations where PPCI is not feasible, fibrinolysis remains a vital treatment option. Fibrinolysis involves the use of clot-busting medications to restore blood flow in the affected coronary artery. Over the years, various fibrinolytic agents have been employed in clinical practice, including alteplase, reteplase, tenecteplase, and streptokinase, with streptokinase being the most frequently used in countries like Pakistan [6].

Streptokinase, a non-fibrin-specific thrombolytic agent, has been widely used in STEMI management, particularly in cases where timely access to PCI is not possible. The first use of thrombolytic therapy in patients with acute myocardial infarction was documented in 1958 by Fletcher et al., and numerous trials in the 1970s confirmed the efficacy of intravenous streptokinase [7,8]. In STEMI cases, thrombolytic therapy is generally safe and effective, particularly when administered within the first 1.5 to 3 hours of symptom onset [9]. In Pakistan, thrombolysis with streptokinase remains the preferred method of reperfusion, with recent thrombolytic agents achieving coronary artery patency in approximately 60% of cases. However, the time taken for MI patients to reach a healthcare facility plays a more significant role in treatment success than the type of thrombolytic drug used [10].

Several factors may influence the resolution of ST-segment elevation after thrombolysis, including hypertension, diabetes, smoking, gender, family history of ischemic heart disease, and dyslipidemia [11]. A study by Muhammad Said Nawaz et al. identified hypertension, gender, diabetes, smoking, and family history as key factors associated with poor ST-segment resolution after thrombolysis [12]. The goal of this study is to assess the post-thrombolytic resolution of STEMI in patients and to identify factors such as age, gender, smoking, family history, hypertension, diabetes, dyslipidemia, and renal disease that may influence the effectiveness of thrombolysis. By identifying these factors, the study aims to contribute to optimizing STEMI treatment and informing future therapeutic strategies. Moreover, this research will provide a foundation for further studies to explore the underlying mechanisms of factors associated with ST-segment resolution failure, ultimately advocating for the establishment of PPCI facilities in every healthcare center in Pakistan to avoid reliance on less effective treatments like streptokinase.

This study seeks to evaluate the effectiveness of thrombolysis in resolving ST-segment elevation in STEMI patients and to identify the associated factors that may impact treatment outcomes, with the aim of improving therapeutic strategies in the future.

METHODOLOGY

Study Design: This was a cross-sectional study designed to assess the outcomes of pharmacological revascularization in patients with acute STEMI receiving thrombolytic therapy. The study aimed to evaluate the resolution of ST-segment changes and the associated factors influencing this outcome, such as comorbidities and adverse reactions to treatment.

Ethics: Ethical approval for the study was granted by the Ethics Committee of Bacha Khan Medical College (BKMC), Mardan. Prior to participation, the study's objectives, procedures, potential risks, and benefits were communicated clearly to all patients. Informed consent was obtained from all participants, ensuring voluntary participation in accordance with ethical guidelines.

Setting: The study was conducted in the cardiology departments of Mardan Medical Complex (Mardan) and Bacha Khan Medical Complex (Swabi), both located in Khyber Pakhtunkhwa, Pakistan. The data collection occurred over a six-month period, from June to November 2023.

Participants: The study included acute STEMI patients of both genders, aged 30-90 years, who presented within 12 hours of chest pain onset and were eligible for pharmacological revascularization with thrombolytic therapy (e.g., streptokinase). Patients who received thrombolytic therapy within this 12-hour window were included. The study used a convenient sampling technique to select participants.

Exclusion criteria comprised individuals with a history of old myocardial infarction (MI), pregnant women presenting with MI, patients with valvular heart disease, and those with contraindications to thrombolytic therapy, such as active bleeding, allergy to thrombolytic agents, recent major surgery, a history of intracranial hemorrhage, or known bleeding disorders.

Variables: The study primarily focused on the resolution of ST-segment elevation following thrombolytic therapy, as measured through ECG changes. Several key variables were examined, including demographic factors such as age, gender, smoking history, and family history of heart disease. Clinical variables considered in the analysis included recovery time, type of myocardial infarction (MI), and associated comorbidities like diabetes mellitus, hypertension, dyslipidemia, and renal disease. The outcome variables of interest were ST-segment resolution, as reflected in baseline and post-thrombolytic therapy ECG changes, as well as any adverse reactions to the thrombolytic therapy administered.

Data Sources/Measurement: Data were collected using a pre-designed questionnaire, which was administered to the patients after informed consent was obtained. The questionnaire included questions related to demographic information (patient ID, age, gender), clinical history (e.g., smoking, family history), and treatment-related data (e.g., recovery time, adverse reactions, and resolution of ST-segment). Clinical data such as baseline and post-thrombolytic ECG changes were also recorded.

Data was analyzed using IBM SPSS software (version 22). The resolution of the ST-segment was assessed through baseline and post-thrombolytic ECG readings, and recovery time was noted.

Bias: To minimize bias, the study employed a convenient sampling technique, and all participants were equally informed of the study's purpose and potential risks. However, selection bias may have been introduced due to the non-random sampling method. To reduce the potential for measurement bias, all ECG readings and clinical evaluations were performed by trained professionals using standardized protocols. Furthermore, patient information was recorded in a consistent manner to ensure accuracy and reliability.

Study Size: A sample size of 222 was calculated using OpenEpi, with a 95% confidence interval, an anticipated frequency of 17.5%, and a design effect of 1. This sample size was deemed sufficient to detect statistically significant differences in ST-segment resolution among patients with different comorbid conditions and adverse reactions.

Quantitative Variables: The study considered several quantitative variables in the analysis, including age, which was measured in years, and recovery time, defined as the number of hours taken for the resolution of chest pain after thrombolytic therapy. Additionally, baseline and post-thrombolytic therapy ECG changes were assessed, specifically the number of leads showing ST-segment resolution. Descriptive statistics, including means and standard deviations (SD), were calculated for these continuous variables. Frequencies and percentages were also computed for categorical variables, such as gender, smoking history, family history, and comorbidities.

Statistical Methods: Data were analyzed using IBM SPSS software (version 22). Descriptive statistics, including frequency tables and measures of central tendency (mean, standard deviation), were used to summarize the demographic and clinical characteristics of the participants. Chi-square test was employed to assess the association between ST-segment resolution and associated factors, such as diabetes mellitus, hypertension, dyslipidemia, and renal disease. A p-value of <0.05 was considered statistically significant, indicating a meaningful relationship between the variables of interest.

RESULTS

Participants: A total of 222 patients were included in the study, with a mean age of 57.9 ± 10.81 years. Among the patients, 136 (61.3%) were male and 86 (38.7%) were female. The study focused on a diverse group of patients, including various age groups and comorbidities, with the aim of assessing the resolution of ST-segment elevation following thrombolytic therapy.

Table 1: Frequency and percentage of Risk Factors and Comorbidities in STEMI Patients

Associated Factors	n (%)
Total (N)	**222**
Family History	78 (35.1)
Smoking History	52 (23.4)
Adverse reaction to thrombolytic therapy	5 (2.3)
Diabetic Mellitus	80 (36)
Hypertension	137 (61.7)
Dyslipidemia	91 (41)
Renal Disease	25 (11.3)

%: Percentage, n: Number

Descriptive Data: Table 1 presents the frequencies of key clinical factors, including family history, smoking history, and comorbidities. The most common associated factor was hypertension, which was present in 137 patients (61.7%), followed by dyslipidemia (41%), diabetes mellitus (36%), and renal disease (11.3%). Smoking history was reported in 52 patients (23.4%), while adverse reactions to thrombolytic therapy occurred in only 5 patients (2.3%). Table 2 outlines the distribution of myocardial infarction (MI) locations, with the anterior wall being the most common, observed in 45.5% of the patients. The least frequent MI types were the anterolateral wall (3.6%) and inferioposterior wall (4.5%). Table 3 summarizes baseline ECG findings and post-thrombolytic therapy changes, as well as the extent of ST-segment resolution. Baseline ECG changes ranged from 1.0 mm to 7.0 mm, with the majority of patients (30.2%) showing a change of 3.0 mm. Post-thrombolytic therapy ECG changes showed the highest frequency of 1.0 mm (33.8%), with significant numbers of patients experiencing partial resolution of the ST-segment (51.8%).

Table 2: Distribution of Myocardial Infarction Location in STEMI Patients

Type of MI	n (%)
Total (N)	**222**
Anterior Wall	101 (45.5)
Inferior Wall	74 (33.3)
Lateral Wall	15 (6.8)
Inferioposterior Wall	10 (4.5)
Anterolateral Wall	8 (3.6)
Others	14 (6.3)

MI: Myocardial Infarction, STEMI: ST segment elevation myocardial infarction

Outcome Data: The primary outcome of the study was the resolution of the ST-segment elevation after thrombolytic therapy. ST-segment resolution was categorized as complete (>70% resolution), partial (30-70% resolution), or failed (<30% resolution). Of the 222 patients, 61 (27.5%) experienced complete ST-segment resolution, 115 (51.8%) had partial resolution, and 46 (20.7%) had failed resolution.

Table 3: Analysis of Baseline ECG Changes, Post-Thrombolytic ECG Findings, and ST-Segment Resolution

Variable	ST change in mm	Frequency (%)
Total (N)		**222**
Baseline ECG changes	1.0	04 (1.8)
	1.5	05 (2.3)
	2.0	50 (22.5)
	2.5	8 (3.6)
	3.0	67 (30.2)
	4.0	62 (27.9)
	5.0	15 (6.8)
	6.0	07 (3.2)
	7.0	04 (1.8)
Post SK ECG changes	0.5	27 (12.2)
	1.0	75 (33.8)
	1.5	07 (3.2)
	2.0	65 (29.3)
	2.5	03 (1.4)
	3.0	32 (14.4)
	4.0	11 (5.0)
	5.0	02 (9)
Resolution of ST segment	Complete (>70%)	61 (27.5)
	Partial (30-70%)	115 (51.8)
	Failed (<30%)	46 (20.7)

mm: millimeter, %: percentage ,SK: Streptokinase

Main Results: Chi-square tests were conducted to assess the association between ST-segment resolution and various demographic and clinical factors. The results showed a significant relationship between ST-segment resolution and hypertension (p=0.026), indicating that patients with hypertension were more likely to have partial or complete resolution of the ST-segment. However, no significant associations were found between ST-segment resolution and age (p=0.144), diabetes mellitus (p=0.786), dyslipidemia (p=0.879), or renal disease (p=0.818), as summarized in Table 4. These findings suggest that while hypertension appears to influence the outcome of thrombolytic therapy, other clinical factors did not show a statistically significant impact on the resolution of ST-segment elevation.

Table 4: Association of Demographic and Clinical Variables with ST-Segment Resolution in STEMI Patients

Variable		Resolution of ST segment			*p*-value
		Complete >70%	Partial 30-70%	Failed <30%	
Age (Years)	30-45	14	10	8	0.144
	46-60	28	61	22	
	61-75	16	38	16	
	76-90	3	6	0	
Diabetic Mellitus	Yes	20	42	18	0.786
	No	41	73	28	
Hypertension	Yes	29	76	32	0.026
	No	32	39	14	
Dyslipidemia	Yes	24	49	18	0.879
	No	37	66	28	
Renal Disease	Yes	7	14	4	0.818
	No	54	101	42	

DISCUSSION

In our study, we examined the relationship between diabetes, hypertension, and other factors on the resolution of ST-segment elevation following thrombolysis in STEMI patients. Among the 222 patients, 80 had diabetes, while 142 were non-diabetic. Of the 80 diabetics, 20 (25%) showed complete resolution of ST-segment elevation following thrombolysis, 42 (52.5%) had partial resolution, and 18 (22.5%) had no significant resolution. In contrast, among the 142 non-diabetic patients, 41 (28.8%) experienced complete resolution, 73 (51.4%) had partial resolution, and 28 (19.7%) did not respond to thrombolytic therapy. Despite these differences, the remission of ST-segment elevation between diabetic and non-diabetic patients was found to be statistically insignificant (p>0.05), which contrasts with findings from Zairis et al., who reported significant differences in ST-segment resolution between diabetic and non-diabetic patients (complete resolution: 34.1% vs. 68.2%; p<0.001). This discrepancy may be attributed to the fact that diabetic patients typically have higher levels of plasminogen activator inhibitor-1, which negatively affects thrombolytic therapy efficacy, making them less responsive to treatment. Uddin et al. [13] also observed that after receiving streptokinase, non-diabetic patients showed better segmental function improvement, indicating more successful reperfusion compared to diabetics [14].

Regarding hypertension, among the 91 hypertensive patients in our study, 29 (31.8%) experienced complete ST-segment resolution, while 32 (24.4%) of the 131 non-hypertensive patients had complete resolution. This difference was statistically significant (p=0.025), suggesting that hypertensive patients responded better to thrombolytic therapy compared to non-hypertensive patients. A similar study found that hypertensive individuals had a higher rate of complete ST-segment resolution (42.62%) compared to non-hypertensive individuals (77.27%), with a significant p-value of 0.019. The beneficial effects of hypertension on thrombolysis may be related to factors such as advanced age, higher prevalence of diabetes, and more severe coronary artery disease in hypertensive patients. Additionally, higher diastolic pressure may enhance collateral circulation and coronary perfusion, improving the effectiveness of reperfusion therapy and limiting infarct size. Furthermore, a thicker left ventricle (LV) in hypertensive patients may benefit LV remodeling by reducing LV dilatation [15].

Our study also investigated the effects of dyslipidemia and infarction location on ST-segment resolution. However, we found that neither dyslipidemia nor the location of the infarction significantly affected the resolution of ST elevation following thrombolysis. This finding is consistent with the lack of significant associations in other studies, suggesting that other factors may play a more pivotal role in determining thrombolytic success.

When analyzing patients with renal disease, our results showed that only 7 out of 25 patients (28%) with renal disease had complete ST-segment

resolution, compared to a higher percentage of patients without renal disease. This difference was statistically insignificant (p=0.818), but it suggests that renal disease may adversely affect the efficacy of thrombolytic therapy. This finding aligns with research indicating that patients with chronic kidney disease (CKD) experience lower rates of reperfusion success. A study found that individuals with CKD had a reperfusion success rate of 67.2%, whereas those without CKD had a success rate of 83.1% [16].

Limitations: This study has several limitations, including its cross-sectional design and the use of convenient sampling methods, which may introduce selection bias. Additionally, the study was conducted at only two tertiary care hospitals, limiting the generalizability of the results to other regions, such as Mardan and Swabi. The study also focused on patients who presented to the hospital within 12 hours of the onset of symptoms, which may not represent the broader STEMI patient population.

CONCLUSION

Our study highlights that complete ST-segment resolution following thrombolytic therapy was less common than partial resolution. We also observed that hypertension, when present, appeared to enhance the effectiveness of thrombolysis, whereas diabetes, dyslipidemia, and renal disease did not significantly impact the success of thrombolytic therapy in STEMI patients.

Healthcare institutions and policymakers should consider implementing standardized thrombolytic therapy protocols and post-treatment monitoring to optimize patient outcomes. Future research should explore the long-term effects of thrombolysis on ST-segment resolution by conducting longitudinal studies that track patients over time. Additionally, studies investigating genetic markers, inflammation markers, and variations in response to thrombolytic agents could offer deeper insights into factors influencing treatment outcomes. Expanding research to include multiple tertiary healthcare hospitals will improve the generalizability of findings and assess the impact of regional factors on thrombolytic efficacy. Establishing primary percutaneous coronary intervention (PPCI) programs could also improve outcomes for patients with STEMI in areas with limited access to thrombolytic therapy

AUTHORS' CONTRIBUTION

MI, AAK, HW, FUB, SAS, SAU, and AUS: Concept and design, data acquisition, interpretation, drafting, final approval, and agree to be accountable for all aspects of the work. MI, AAK, HW, FUB, SAS, SAU, and AUS: Data acquisition, interpretation, drafting, final approval and agree to be accountable for all aspects of the work.

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