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Coronary angiographic assessment of streptokinase efficacy in young patients with ST-elevation myocardial infarction

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ABSTRACT

Background: Thrombolytic therapy has emerged as one of the most effective interventions for acute myocardial infarction, a condition that is the leading cause of mortality worldwide. **Aims and Objectives:** This study aimed to evaluate the efficacy and clinical outcomes of Streptokinase (SK) in young patients with ST-elevation myocardial infarction (STEMI) based on coronary angiography performed 12–24 h post-thrombolysis. **Materials and Methods:** This observational, cross-sectional study included 50 patients diagnosed with STEMI of age between 18 and 40 years and treated with SK between September 2022 and August 2023 in India. The efficacy of SK was assessed through coronary angiography performed 12–24 h post-thrombolysis and ST-segment resolution on electrocardiogram. Clinical outcomes, including adverse events and mortality, were recorded. **Results:** The majority of patients (66%) were 31–40 years old, with males constituting 88% of the population. Single vessel disease was predominant (84%) among the study population. Anterior wall myocardial infarction emerged as the predominant type of infarction, accounting for 56% of patients in the present study. Successful thrombolysis was achieved in 67.85% of patients treated within 3 h of symptom onset. Adverse events occurred in 52% of patients, with left ventricular failure being the most frequent complication (36%), followed by arrhythmia (26%). The study observed a relatively low mortality rate of 8% among young patients with STEMI. **Conclusion:** Coronary angiography findings demonstrate that SK is effective in treating young patients with STEMI, particularly when administered within 3 h of symptom onset. Despite frequent adverse events, mortality rates remained low.

Key words: Acute myocardial infarction; Mortality; Streptokinase; ST-elevation myocardial infarction; Thrombolytic therapy; Young adult

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INTRODUCTION

In recent years, cardiovascular disease has become the leading cause of mortality globally, with its prevalence continuing to rise. Among cardiovascular conditions, acute myocardial infarction (AMI) stands out as a significant contributor to both death and disability worldwide[1,2] including ST-elevation myocardial infarction (STEMI), a critical subset of AMI characterized by a specific pattern on an electrocardiogram (ECG). The STEMI typically indicates a complete blockage of a coronary artery and requires immediate medical intervention due to its life-threatening nature. While primary percutaneous coronary intervention (PCI) is considered the gold standard for treating STEMI, fibrinolytic therapy remains a crucial alternative in scenarios where timely PCI is not feasible.[2,3] The significance of fibrinolysis as a reperfusion strategy is underscored by its ability to prevent approximately 30

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early deaths per 1000 patients when administered within 6 h of symptom onset. Among the various fibrinolytic agents available, streptokinase (SK) is the most widely utilized, particularly in resource-constrained settings. This preference of SK is primarily due to its lower cost compared to newer generations of fibrinolysis such as tissue plasminogen activator (t-PA).[2-4]

Recent global trends indicate a rising incidence of AMI among young adults.[5] Concurrently, elderly patients with STEMI stand to benefit significantly from reperfusion strategies such as thrombolytic therapy, despite facing an elevated risk of adverse events.[3] Interestingly, although data are limited, observations suggest that the clinical and coronary angiographic profiles differ substantially between young and elderly patients.[6] This study seeks to bridge this knowledge gap by evaluating the efficacy and clinical outcomes of SK in young patients with STEMI based on coronary angiography performed 12–24 h post thrombolysis.

MATERIALS AND METHOD

The present study is a cross-sectional study conducted from September 2022 to August 2023 in India.

Inclusion and exclusion criteria

The study included patients aged 18–40 years diagnosed with STEMI and administered SK during the study period, who provided informed consent. Exclusion criteria encompassed patients with a history of acute coronary syndrome or coronary revascularization, atypical chest pain, vascular heart disease, cardiomyopathy, bundle branch block, congenital heart disease, or contraindications to thrombolytic therapy. In addition, patients presenting to the hospital more than 12 h after symptom onset and pregnant or lactating women were excluded from the study. A total of 50 patients meeting the pre-defined inclusion criteria were enrolled in the study.

The study was approved by the Institutional Ethics Committee on 12/9/22 before embarking on this study (IEC/M.C/2022/20883).

Data collection

Study participants underwent interviews, with data recorded in a pre-designed pro forma. A detailed history was obtained from each patient, followed by a thorough physical examination. Demographic information, including age and gender, was collected alongside coronary artery disease (CAD) risk factors such as diabetes mellitus, hypertension, smoking, alcohol consumption, body mass index, and family history. Laboratory investigations included fasting blood sugar (FBS), Post-prandial blood sugar (PPBS), lipid profile, blood urea, serum creatinine, urine albumin, and troponin T level were measured. In addition, ECG recordings were obtained for all patients before SK administration and 180 min post-thrombolysis.

The STEMI was diagnosed based on the presence of characteristic ischemic chest pain and ECG criteria, specifically ST elevation of >1 mm in two consecutive leads. Angiographic severity was assessed visually in at least two orthogonal views. Obstructive CAD was defined as 70% stenosis in a major epicardial artery (left anterior descending artery, left circumflex artery, right coronary artery) or their major branches, or 50% stenosis in the left main coronary artery. Patients were classified as having single-vessel disease (SVD). Double vessel disease (DVD), or triple-vessel disease (TVD). Lesions not meeting these criteria were categorized as non-obstructive CAD.

Clinical outcomes of fibrinolysis were evaluated based on the obtained values. The efficacy of SK was assessed through coronary angiography performed approximately 12–24 h post-thrombolysis. Successful thrombolysis was defined as a thrombus reduced to 70% in the affected coronary artery. Conversely, if the angiography revealed 70% or greater persistent thrombus occlusion, was defined as failed thrombolysis. In addition, ST-segment resolution on ECG was evaluated at 90 min post-thrombolysis. Resolution was categorized as category A: complete (>70% reduction), category B: partial (30–70% reduction), or category C: no resolution (<30% resolution). Post-thrombolysis adverse events were observed and recorded. These events included left ventricular failure (LVF), arrhythmia (AR), recurrent angina (RA), and cardiogenic shock (CS). Mortality among the study population was also documented following thrombolysis treatment.

Statistical analysis

The data compilation was done using Microsoft Excel. The variables were expressed as numbers and percentages. For normally distributed data, comparisons between groups were performed using Student's t-test. $P<0.05$ was considered as statistically significant throughout the analysis.

RESULT

The study included 50 patients, with the majority (66%) falling in the 31–40 years age group. Males constituted 88% of the study population. Among the risk factors, smoking was the most prevalent (22%). All risk factors showed statistical significance ($P<0.001$). Regarding CAD findings, SVD was predominant, affecting 84% of patients, while DVD was observed in 16% of cases. The baseline characteristics of the patients are detailed in Table 1.

The study analyzed various laboratory parameters among the patients and summarized them in Table 2. Hemoglobin levels above 11.0 g/dL were observed in 82% of patients, while 78% had a total leukocyte count (TLC) exceeding 11,000 cells/uL. Urine albumin was negative in 92% of patients. Troponin T was positive in 48% of cases. Statistically significant differences (P<0.001) were observed for hemoglobin, TLC, FBS, low-density lipoprotein (LDL), serum creatinine, and urine albumin levels. PPBS, blood urea, and troponin T results did not show statistical significance (P>0.05).

The study analyzed thrombolysis outcomes in relation to pain-to-needle time, risk factors, and ST segment resolution (Table 3). Among the 50 patients, 28 received thrombolysis within 3 h of pain onset, with a success rate of 67.85%. This group showed a statistically significant difference in outcomes (P=0.0079). Thrombolysis administered between 4–6 h and 7–10 h had success rates of 46.15% and 33.33%, respectively, but these differences were not statistically significant. Risk factors, including diabetes, smoking, and hypertension, were significantly associated with thrombolysis outcomes (P<0.001). Smoking was the most prevalent risk factor, observed in 11 patients, with a thrombolysis failure rate of 63.64%. ST segment resolution was categorized into three groups. Category C (>70% resolution) showed the highest success rate for thrombolysis at 88.23%, while Category A (<30% resolution) had the lowest success rate at 21.42%. Category B (30–70% resolution) demonstrated an intermediate success rate of 52.63%.

Figure 1 demonstrates the distribution of myocardial infarction types among the patients. Anterior wall myocardial infarction (AWMI) was found to be the most prevalent, accounting for 56% of cases followed by inferior wall involvement, observed in 22% of patients. While lateral and posterior wall infarctions were comparatively less common 12% and 10%, respectively. The study examined the outcomes of patients following treatment which is illustrated in Figure 2.

Adverse events were observed in most of them, affecting 52% of the study patients with 8% mortality among all. The relatively low mortality rate suggested that despite the high incidence of adverse events, fatal outcomes were comparatively infrequent. The distribution of adverse events among patients is illustrated in Figure 3 which demonstrates LVF emerged as the most common complication, occurring in 36% followed by AR in 26% of the patients. RA was observed in 22% of patients and CS in 10% of the population.

Table 1: Baseline characteristics of the patients

Variables	n=50 patients	P-value
Age, n (%)		
20–30 years	11 (22)	-
31–40 years	33 (66)	-
Male, n (%)	44 (88)	-
Risk factors, n (%)		
Smoking	11 (22)	<0.001
Hypertension	4 (8)	<0.001
Diabetes mellitus	3 (6)	<0.001
Alcohol	3 (6)	<0.001
History of angina	3 (6)	<0.001
Family history of IHD	6 (12)	<0.001
CAD findings, n (%)		
SVD	42 (84)	-
DVD	8 (16)	-

P<0.05 was considered statistically significant
CAD: Coronary artery disease; DVD: Double vessel disease; IHD: Ischemic heart disease; SVD: Single vessel disease

Table 2: Laboratory investigation among the population

Variables	n=50 patients	T-test	P-value
Hemoglobin, (g/dL; n (%))			
≤11.0	9 (18)	20.45	<0.001
>11.0	41 (82)		
TLC, (WBC/microliter; n (%))			
≤11000	11 (22)	15.68	<0.001
>11000	39 (78)		
FBS, (mg/dL; n (%))			
≤110	39 (78)	15.68	<0.001
>110	11 (22)		
PPBS, (mg/dL; n (%))			
≤140	26 (52)	0.080	>0.05
>140	24 (48)		
LDL, (mg/dL; n (%))			
≤150	13 (26)	11.52	<0.001
>150	37 (74)		
Blood urea, (mg/dL; n (%))			
≤40	34 (68)	6.48	>0.05
>40	16 (32)		
S. creatinine, (mg/dl; n (%))			
≤1.0	36 (72)	9.68	<0.001
>1.0	14 (28)		
Urea albumin, n (%)			
Positive	4 (8)	35.28	<0.001
Negative	46 (92)		
Troponin T, n (%)			
Positive	24 (48)	0.080	>0.05
Negative	26 (52)		

P<0.05 was considered statistically significant
FBS: Fasting blood glucose, LDL: Low-density lipoprotein, PPBS: Post-prandial blood sugar, TLC: Total leukocyte count, WBC: White blood cells

DISCUSSION

Histological evidence suggests that coronary plaques in younger patients have distinct characteristics that may contribute to their increased vulnerability. These plaques typically contain higher lipid content and less cellular scar tissue compared to those in older individuals. They

Table 3: Successful thrombolysis according to parameters in correlation of coronary angiography report

Variables	Total number	Successful thrombolysis	Failed thrombolysis	T-test	P-value
Pain to needle time, n (%)					
30 min–3 h	28	19 (67.85)	9 (32.15)	9.67	0.0079
4–6 h	13	6 (46.15)	7 (53.85)	3.30	0.1913
7–10 h	9	3 (33.33)	6 (66.67)	3.00	0.2231
Risk factors, n (%)					
Diabetes	3	1 (33.33)	2 (66.67)	-	-
Smoking	11	4 (36.36)	7 (63.64)		
Hypertension	4	2 (50.0)	2 (50.0)		
ST segment resolution, n (%)					
Category A (<30%)	14	3 (21.42)	11 (78.58)	14.04	<0.001
Category B (30–70%)	19	10 (52.63)	9 (47.37)		
Category C (>70%)	17	15 (88.23)	2 (44.0)		

P<0.05 was considered statistically significant

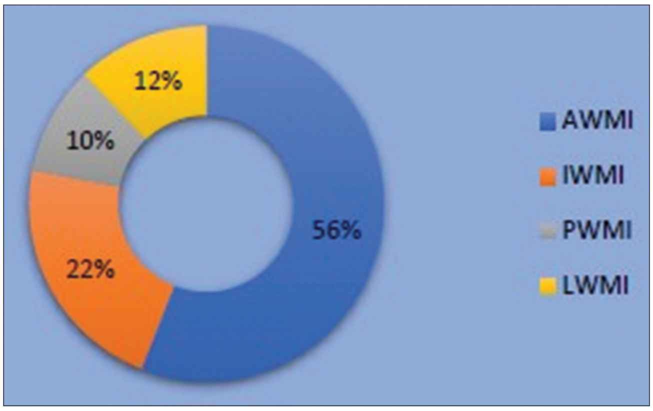

Figure 1: Types of infarction observed among the patients. AWMI: Anterior wall myocardial infarction; IWMI: Inferior wall myocardial infarction; LWMI: Lateral wall myocardial infarction; PWMI: Posterior wall myocardial infarction

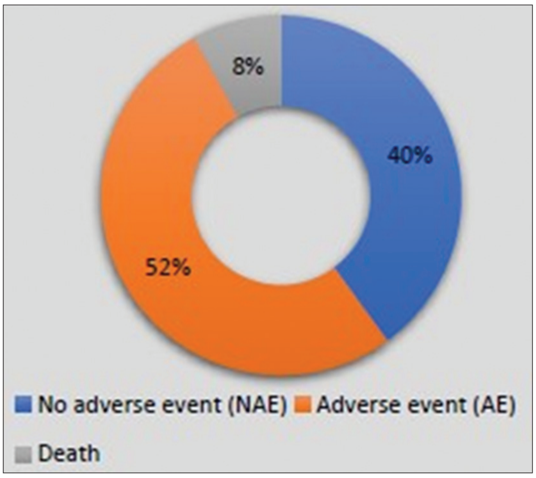

Figure 2: Outcomes among the study patients after thrombolytic treatment with streptokinase

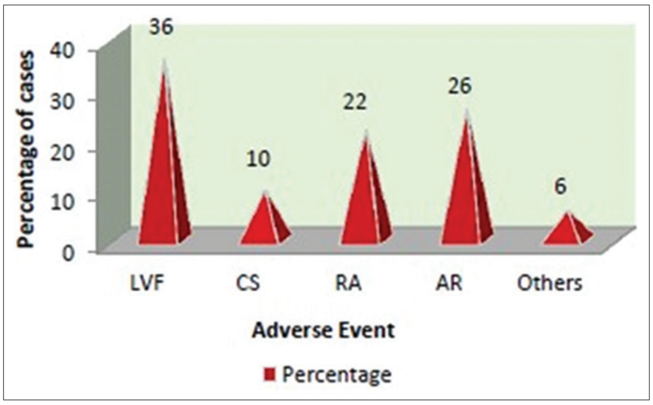

Figure 3: Types of adverse events observed during the study. AR: Arrythmia; CS: Cardiogenic shock; LVF: Left ventricular failure; RA: Recurrent angina

also tend to develop more rapidly or exist for shorter duration. This composition makes these plaques more susceptible to rupture, potentially explaining the higher incidence of STEMI. In addition, frequent exposure to high-stress events in younger individuals may further destabilize these plaques.[7] These factors highlight the unique pathophysiology of STEMI in younger patients and underscore the need for an age-specific treatment strategy. Therefore, the study aimed to find out the clinical efficacy of SK in young patients with STEMI.

Most patients exhibited elevated LDL levels (P<0.05) in our study, aligning with the established pathophysiology of STEMI in young patients. This finding corroborates previous research on the Indian population, when identified increased LDL as a significant contributor to CAD.[8] Ideally, patients should receive SK as soon as possible after symptom onset, with benefits observed in patients presenting up to 12 h. A previous study's subgroup analysis of time from the index event found that those presenting earlier had higher patency rates compared to those presenting later. Furthermore, the study observed better results after thrombolysis with SK in young compared to older patients.[9] Our study similarly observed that the group receiving SK within 3 h had a higher number of patients with successful thrombolysis compared to groups receiving it later. Chaturvedi et al. in their study also reported similar findings.[10] The GISSI-1 trial, the first major trial on thrombolytic therapy in patients with AMI, demonstrated significant mortality benefits of SK compared to no treatment. The trial showed that patients receiving SK within 1 h of symptom onset had a mortality rate of 8.2% versus 15.4% in the untreated group. For those treated within 3 h, mortality rates were 9.2% with SK versus 12% without. Even patients treated between 3 and 6 h after symptom onset showed improvement, with mortality rates of 11.7% in the SK group compared to 14.1% in the untreated group.[11] These results clearly illustrate the life-saving potential of SK, particularly when administered early in patients with AMI.

Various studies have identified the resolution of ST-segment elevation as a useful predictor of final infarct size, with category C, ST-segment resolution (>70%) often used to indicate successful thrombolysis.[10,12] In our study, we observed ST-segment resolution and compared it with coronary angiography findings. Notably, two patients in category C of ST resolution were found to have failed thrombolysis based on angiographic criteria, highlighting potential discrepancies between ECG-based and angiographic assessments of reperfusion success.

A meta-analysis reported a high number of adverse events due to SK.[13] Similarly, our results showed that 52% of patients experienced SK-related adverse events. Despite this high incidence, we observed only 8% mortality among our study population. Another study observed similar adverse events to our findings, with LVF being the most common adverse event in the no-resolution group, followed by CS. However, their reported mortality rate was higher than in our study, which may be due to more older patients in their study.[10] Large, placebo-controlled clinical trials have demonstrated that SK treatment reduces death rates in patients suffering from AMI.[11] Arrhythmia was reported as the most common adverse event in several other studies,[3,10,13] while in our study it emerged as the second most frequent complication. While studies have noted bleeding and anaphylactic shock after SK administration,[3,11] were not observed in our study. The absence of major bleeding in our study may be attributed to the relatively younger age of patients.

Limitations of the study

The sample size was relatively small, which may limit the generalizability of the findings to larger populations. As a single-center study, the results may not be representative of diverse geographic or demographic settings. In addition, the study lacked a control group for direct comparison, which could have provided more accurate evidence of SK efficacy. Future multi-center, prospective studies with larger sample sizes and longer follow-up periods are needed to address these limitations and further validate our findings.

CONCLUSION

Coronary angiography findings indicate that SK is effective in treating young patients with STEMI, with optimal results observed when administered within 3 h of symptom onset. Whereas, SVD predominated, with AWMI being the most common presentation. Despite frequent adverse events, mortality rates remained low. LVF emerged as the primary complication, followed by arrhythmia. These findings underscore the importance of early thrombolysis and support the use of SK as a viable treatment option for young STEMI patients, especially in resource-limited settings.

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Author contributions:
CS- Definition of intellectual content, Literature survey, Prepared first draft of manuscript, implementation of study protocol, data collection, data analysis, manuscript preparation and submission of the article; Concept, design, clinical protocol, manuscript preparation, editing, and manuscript revision; Manuscript Literature survey; **KDS-** Concept, design, clinical protocol, manuscript preparation, editing, and manuscript revision; Design of study, statistical Analysis and Interpretation, data collection, data analysis, manuscript preparation, Concept, design, manuscript preparation and editing; **SKT-** Definition of intellectual content, Literature survey, Prepared first draft of manuscript, implementation of study protocol, data collection, data analysis, manuscript preparation, Concept, design, clinical protocol, manuscript preparation, editing, and manuscript revision; Design of study, statistical Analysis and Interpretation; **MI-** Review Manuscript Literature survey and preparation of Tables, Coordination and Manuscript revision; **RKT-** Design of study, statistical Analysis and Interpretation, Coordination and Manuscript revision.

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