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Original Article

Frequency of Total Coronary Artery Occlusion after Successful Thrombolysis in Acute ST-Elevated Myocardial Infarction (STEMI) Patients

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Abstract

Objectives: To determine the frequency of total coronary artery occlusion following successful thrombolysis in patients with acute STEMI.

Methodology: This study included 149 patients diagnosed with acute STEMI who achieved ≥50% resolution of ST-segment elevation within 90 minutes of thrombolytic therapy (successful thrombolysis). During their hospitalization, all patients underwent coronary angiography to assess the frequency of total coronary artery occlusion.

Results: The mean age of the patients was 54.34 years (SD ± 10.8), with a gender distribution of 104 males (69.8%) and 45 females (30.2%). Despite meeting ECG criteria for successful thrombolysis, 10 patients (6.7%) had total occlusion of the culprit artery on coronary angiography. Of these 10 patients, 9 (8.7%) were male, and 1 (2.2%) was female ($p = 0.15$). Total occlusion of the culprit artery was significantly higher in older patients, particularly those in the 61-70 years age group, where 5 out of 25 patients (20.2%) experienced occlusion ($p = 0.04$). Similarly, patients with delayed thrombolysis (9-12 hours after symptom onset) exhibited a significantly higher rate of total artery occlusion, with 6 out of 13 patients (46.2%) showing occlusion ($p < 0.001$). A non-significant trend toward higher rates of total occlusion was observed when angiography was performed on the second day of hospitalization. Regarding the localization of STEMI on the ECG, the majority of patients had an anterior wall MI (LAD territory) with 57.05% of cases, while coronary angiography revealed that total occlusion of the culprit artery was most commonly seen in the RCA (5 cases, 11.1% of total occlusions) ($p = 0.477$).

Conclusion: Total occlusion of the culprit artery in patients who met ECG criteria for successful thrombolysis was more prevalent in elderly patients and those with delayed presentation, highlighting the importance of timely intervention in STEMI management.

Keywords: ST-elevated myocardial infarction, thrombolysis, ST-segment resolution, total coronary artery occlusion

INTRODUCTION

The primary goal of intravenous thrombolytic therapy in the management of acute ST-Elevation Myocardial Infarction (STEMI) is to restore adequate blood flow to the occluded infarct-related coronary artery, thereby re-perfusing the ischemic myocardium as quickly as possible. This approach aims to prevent life-threatening arrhythmias, heart failure, and other mechanical complications [1]. Multiple studies have established that successful thrombolysis significantly reduces both morbidity and mortality. In contrast, failed thrombolysis is associated with complex arrhythmias and increased in-hospital and 30-day mortality [2].

ST-segment resolution on the electrocardiogram (ECG) after thrombolysis is the most commonly used non-invasive method to assess the success of the procedure and to stratify patient risk. However, while ECG plays a crucial role, it has limitations in accurately predicting the exact angiographic findings. Several studies have shown that the resolution of ST-segment elevation in STEMI patients, when compared to coronary angiographic results (TIMI flow grades), provides fairly good diagnostic information, with a sensitivity of 94.79%, specificity of 67.69%, and overall accuracy of 84.46% [3].

The time interval between the onset of chest pain and the initiation of reperfusion therapy is one of the most critical factors influencing the success of thrombolysis and the preservation of myocardial tissue [4]. Several studies have demonstrated that shorter time intervals correlate with higher success rates of thrombolysis. Although ST-segment resolution offers useful prognostic insights, research has indicated that when reperfusion therapy is delayed, the predictive value of ST-segment changes becomes less reliable [5].

Following successful thrombolysis, coronary angiography often reveals that 10-15% of patients experience total coronary artery occlusion (TIMI 0 to 1 flow). Factors contributing to re-occlusion include the exposure of ruptured plaques and residual luminal stenosis, which trigger platelet activation, thrombin generation, and systemic coagulation [6]. Additionally, the healing of infarct-related lesions can take more than a month, during which the artery remains unstable and susceptible to re-occlusion, driven by ongoing activation of the coagulation cascade. Some studies have found that approximately 54% of patients with total coronary artery occlusion have early collateral circulation, which can mask typical ECG findings. This collateral circulation reduces wall motion abnormalities, ST-segment changes, and infarct size, potentially influencing thrombolysis outcomes [7].

According to the 2013/2016 AHA/ACC guidelines, coronary angiography is recommended in stable patients after successful thrombolysis, ideally within 3 to 24 hours before discharge. However, several studies have shown that while coronary angiography is a valuable strategy for timely management, its timing after successful thrombolysis does not significantly impact mortality [8]. Meta-analyses comparing early versus delayed invasive strategies after thrombolysis suggest that early PCI within 24 hours is associated with reduced recurrence of ischemia and reinfarction, particularly in patients with intermediate-to-high GRACE risk scores. In contrast, delayed coronary intervention in low-risk patients had no significant benefit [9].

Despite being largely obsolete globally, thrombolytic treatment with streptokinase remains the primary treatment modality for STEMI patients in Khyber Pakhtunkhwa due to limited resources [10]. Studies have shown that approximately 73% of patients achieve successful thrombolysis based on ECG criteria when treated within the recommended window [11]. Follow-up of these patients reveals 9% in-hospital mortality and 11% 3-month mortality, with heart failure occurring in 7% of cases during index hospitalization and 11.11% at 3 months [12-14].

This study was conducted to investigate the frequency of total coronary artery occlusion (TIMI 0 to 1 flow) in patients from Khyber Pakhtunkhwa who underwent thrombolytic therapy with streptokinase for acute STEMI. We aimed to evaluate the success of thrombolysis, as defined by ST-segment resolution of more than 50%, and compare the frequency of total coronary artery occlusion with national and international data. By establishing local data, we can better assess the effectiveness of thrombolytic therapy, identify patients with failed thrombolysis (despite successful ECG results), and implement a

pharmaco-invasive strategy. The findings will also serve as the foundation for developing local treatment guidelines and improving patient outcomes in our healthcare system.

METHODOLOGY

Study Design: This descriptive cross-sectional study aimed to evaluate the factors influencing the success of thrombolytic therapy in patients with acute ST-segment elevation myocardial infarction (STEMI). The study was conducted at the Cardiology Ward of Lady Reading Hospital, Peshawar, from November 2020 to November 2023. It focused on assessing the correlation between time to thrombolytic therapy and the presence of total coronary artery occlusion, as determined by coronary angiography.

Ethics: The study was conducted in compliance with ethical standards, having received approval from the hospital's Ethical and Research Review Board (ERB). Informed written consent was obtained from all participants prior to inclusion in the study. The study adhered to ethical principles regarding confidentiality, voluntary participation, and the right to withdraw without consequence at any point during the research.

Setting: The study was conducted at the Cardiology Ward of Lady Reading Hospital, Peshawar, a tertiary care hospital offering comprehensive cardiovascular care. The hospital has a specialized unit for STEMI patients requiring thrombolytic therapy and coronary angiography, making it an ideal setting for this research.

Participants: A total of 149 patients were recruited for the study, selected based on the following inclusion and exclusion criteria:

Inclusion Criteria:

- Adult patients (≥18 years) diagnosed with acute STEMI, presenting with typical chest pain symptoms and onset of symptoms ≥30 minutes and ≤12 hours before admission.
- Patients who received thrombolytic therapy and achieved ≥50% ST-segment resolution on ECG within 90 minutes of treatment initiation (defined as successful thrombolysis).
- Patients who underwent coronary angiography during the index hospitalization.

Exclusion Criteria:

- Failure to achieve ≥50% ST-segment resolution (non-successful thrombolysis).
- Death before coronary angiography or inability to identify infarct-related artery on ECG.
- Conditions such as coagulopathy, decompensated heart failure, hypertensive crisis, stroke, refractory arrhythmias, pregnancy, active infection, renal failure, contrast medium allergy, and other factors preventing patient cooperation or coronary angiography.

Variables

Primary Variables:

- Successful thrombolysis (defined as ≥50% ST-segment resolution within 90 minutes post-thrombolysis).
- Presence of total coronary artery occlusion, as determined by coronary angiography findings.

Secondary Variables:

- Time elapsed from symptom onset to initiation of thrombolytic therapy.
- Time from MI onset to coronary angiography.
- Demographic variables such as age, gender.
- ECG localization of STEMI (inferior, anterior, etc.).
- Culprit artery involved in coronary occlusion.

Data Sources/Measurement: Data were collected using a structured proforma, documenting patient demographics, clinical presentation, thrombolysis response, and angiographic findings. The timing of thrombolytic therapy initiation, ECG findings, and coronary angiography outcomes were recorded by trained cardiologists and research staff. Successful thrombolysis was confirmed by ≥50% ST-segment resolution, and total coronary occlusion was identified through coronary angiography by an experienced interventional cardiologist.

Bias: Non-probability consecutive sampling was used, ensuring that patients meeting inclusion criteria during the study period were enrolled. This approach may limit generalizability but was necessary for timely inclusion of STEMI patients. Standardized protocols

for thrombolytic administration and coronary angiography were followed, and data collection was conducted by trained research staff to minimize errors in the documentation of outcomes.

Study Size: The sample size was calculated based on a reference study showing a 74.5% successful thrombolysis rate (as per ECG criteria). Using an epitool sample size calculator, with a 95% confidence interval and a 7% absolute precision, the required sample size was estimated to be 149 patients. This sample size was sufficient to detect statistically significant relationships between time to treatment and outcomes.

Quantitative Variables

- **Age:** Measured in years, with mean and standard deviation calculated.
- **Time to thrombolysis:** Measured in minutes from symptom onset to the initiation of thrombolytic therapy.
- **MI to CAG time:** Time in minutes from the onset of myocardial infarction to the performance of coronary angiography.
- **ST-segment resolution:** Percentage of ST-segment resolution post-thrombolysis, used to categorize successful thrombolysis.

Statistical Methods: The data were analyzed using SPSS software, version 23. Descriptive statistics, including frequencies and percentages, were used to summarize categorical variables such as gender, ECG localization of STEMI, and the presence of total coronary occlusion. Continuous variables such as age, time to thrombolysis, and MI to CAG time were summarized using means and standard deviations. Stratification was performed based on variables like age, gender, time to thrombolysis, and culprit artery involved. The chi-squared test was applied to assess associations between these variables and the presence of total coronary occlusion, with a p-value of ≤0.05 considered statistically significant. Results were presented in tabular form for clarity.

RESULTS

Participants: A total of 149 patients were recruited for this study, with a mean age of 54.34 years (SD ± 10.8). Of these patients, 104 (69.80%) were male and 45 (30.20%) were female. Participants were stratified into age groups as follows: ≤30 years (0%), 31–40 years (15.44%), 41–50 years (28.19%), 51–60 years (32.21%), 61–70 years (16.78%), and ≥71 years (7.38%). The majority of patients fell within the 41-60 year age range, with the highest frequency seen in the 51–60 years group (32.21%).

Table 1: Frequencies and percentages of total coronary artery occlusion with respect to total patients, gender, and age groups

Group	Frequency	Total Coronary Artery Occlusion (%)	p-value
Gender			
Males	104 (69.80%)	9 (8.7%)	0.15
Females	45 (30.20%)	1 (2.2%)	
Age Groups			
≤ 30 years	0 (0%)	0 (0%)	
31-40 years	23 (15.44%)	0 (0%)	
41-50 years	42 (28.19%)	3 (7.1%)	0.04
51-60 years	48 (32.21%)	2 (4.2%)	
61-70 years	25 (16.78%)	5 (20%)	
≥ 71 years	11 (7.38%)	0 (0%)	

Descriptive Data: The time from chest pain onset to thrombolysis initiation had a mean duration of 4.06 hours (SD ± 2.76). Patients were categorized into the following time groups: 1–4 hours (59.73%), 5–8 hours (31.54%), and 9–12 hours (8.73%). The mean time from myocardial infarction (MI) to coronary angiography (CAG) was 4.02 days (SD ± 1.75). This delayed time was attributed to the COVID-19 pandemic era, where the pharmaco-invasive strategy was employed, and catheterization laboratories (Cath-Labs) were not operational 24/7 due to operational constraints like weekends and holidays.

Table 2: Frequencies and percentages of total coronary artery occlusion with respect to time period since onset of chest pain to initiation of thrombolysis and time period since MI to coronary angiography

Time Period	Frequency (%)	Total Coronary Artery Occlusion (%)	p-value
Time Since Chest Pain to Thrombolysis			
1–4 hours	89 (59.73%)	1 (1.1%)	
5–8 hours	47 (31.54%)	3 (6.4%)	<0.001
9–12 hours	13 (8.73%)	6 (46.2%)	
Time Since MI to Coronary Angiography			
1–2 days	42 (28.19%)	4 (9.5%)	
3–4 days	56 (37.58%)	3 (5.4%)	0.85
5–6 days	37 (24.83%)	2 (5.4%)	
≥ 7 days	14 (9.40%)	1 (7.1%)	

Outcome Data: Of the 149 patients, 10 (6.71%) experienced total coronary artery occlusion, as determined by coronary angiography. The distribution of total coronary artery occlusion by gender showed 9 (8.7%) male patients and 1 (2.2%) female patient (p = 0.15). The frequency of total coronary occlusion significantly increased with age, as shown in the following age groups: 31-40 years (0%), 41-50 years (7.1%), 51-60 years (4.2%), 61-70 years (20.2%), and ≥71 years (0%) (p = 0.04).

Table 3: Frequencies & Percentages of Total Coronary Artery Occlusion with Respect to ECG Localization of STEMI

ECG Localization of STEMI	Frequency (%)	Total Coronary Artery Occlusion (%)	p-value
LAD Territory	85 (57.05%)	4 (4.7%)	0.477
LCX Territory	12 (8.05%)	1 (8.3%)	
RCA Territory	45 (30.20%)	5 (11.1%)	
PDA Territory	7 (4.70%)	0 (0%)	

Main Results:

Gender and Age Distribution: The total coronary artery occlusion rate among male patients was 8.7% (9/104), and among female patients, it was 2.2% (1/45) (p = 0.15). The frequency of total coronary artery occlusion increased with age, with the highest frequency in the 61-70 years group (20.2%), followed by the 41-50 years group (7.1%) (p = 0.04).

Time from Chest Pain to Thrombolysis: The patients were stratified according to the time from chest pain onset to thrombolysis initiation. The frequency of total coronary occlusion showed a statistically significant increasing trend with the time lapsed to receive thrombolytic therapy. In the 1–4 hour group, only 1.1% (1/89) had total coronary occlusion, compared to 6.4% (3/47) in the 5-8 hour group, and 46.2% (6/13) in the 9-12 hour group (p < 0.001).

Time from MI to Coronary Angiography: Total coronary artery occlusion was observed at similar rates in the stratified time groups (1-2 days, 3-4 days, 5-6 days, ≥7 days) from MI to coronary angiography. There was no significant difference in the occlusion rates across these time groups (p = 0.85).

ECG Localization of STEMI: The localization of STEMI on ECG was as follows: Anterior wall MI (LAD) in 57.05% of patients, Inferior wall MI (RCA) in 30.20%, Lateral wall MI (LCX) in 8.05%, and Posterior wall MI (PDA) in 4.70%. More patients with Inferior wall STEMI (RCA) exhibited total coronary occlusion (11.1%) compared to those with Anterior wall (LAD) MI (4.7%) or Lateral wall (LCX) MI (8.3%), though this difference was not statistically significant (p = 0.477).

DISCUSSION

In our study, the population sample was slightly younger but showed a similar male preponderance compared to previous literature. The mean age was 54.34 years (SD ±10.8), with males comprising 69.8% of the sample. In comparison, de Lemos et al. [15] reported a mean age of 57.5±10.4 years with males at 76.4%, Khursheed et al. [16] found a mean age of 58.9±13.7 years with 62.6% males, and Rao et al. [17] documented a mean age of 63±8.98 years with 86.7% males.

When comparing our study's findings on coronary artery occlusion, we found a lower incidence of total coronary artery occlusion (6.7%) in culprit arteries, as compared to Shaikh et al.3 (22.8%), Guo et al. [18] (14.3%), de Lemos et al. [15] (18.9%), and Belle et al. [7] (7%). This suggests that our treatment protocol with streptokinase may be more effective in reducing total occlusion. Gender-specific analysis revealed that the pattern of total coronary artery occlusion was consistent with the results of previous studies, with the age group 61-70 years showing a significant higher rate of culprit artery occlusion (20%, p=0.04), which is comparable to the findings of de Lemos et al.15 (18.9%) and Girdhar et al. [19] (21%).

The mean time from the onset of chest pain to thrombolysis in our study was 4.06±2.76 hours, aligning with previous studies such as de Lemos et al. [15] (4.0±4.7 hours), and Arab et al. [6] (3.9±2.1 hours). Notably, our study highlights the association between the timing of thrombolysis and the extent of coronary artery occlusion, a factor that has not been extensively explored in previous research. The 2013/16 ACC/AHA guidelines [9] recommend coronary angiography between 3-24 hours after successful thrombolysis in acute STEMI patients. Our study population underwent coronary angiography much later, with a mean of 4.02 days (SD ±1.75) from the onset of MI, which is significantly delayed compared to the recommended guidelines and literature (e.g., Lemos et al. [15], who performed coronary angiography within 80-100 minutes from

chest pain onset, and Shaikh et al. [3], who performed it within 24 hours).

In our cohort, 57.05% of patients had an Anterior Wall Myocardial Infarction (AWMI), a finding consistent with previous studies (de Lemos et al. [15] reported 41.4% and Guo et al. [18] reported 54.5%). Angiographically, we observed more total occlusions in the Right Coronary Artery (RCA) (11.1%) compared to other studies, where de Lemos et al. [15] reported 4.7% total occlusion in LAD and 11% in RCA. This suggests that while most patients in our study had AWMI, total occlusion was more frequently observed in other coronary territories, aligning with previous findings.

Several potential risk factors, such as diabetes, hypertension, smoking, hyperlipidemia, and lifestyle factors, were not included in this study. Consequently, the associations between these factors and total coronary occlusion could not be explored. Additionally, the small sample size (due to an absolute precision of 7%) limits the strength of our statistical conclusions. Previous histories of acute coronary syndrome (ACS) and related treatments/interventions were also not incorporated, further limiting our understanding of chronic total occlusion patterns.

Thrombolytic therapy with streptokinase remains the predominant treatment for acute STEMI in hospitals in Khyber Pakhtunkhwa, despite the increasing preference for Primary Percutaneous Coronary Intervention (PPCI) both nationally and internationally. The rapid detection of failed reperfusion is crucial, as early intervention could re-establish blood flow to the myocardium. Coronary angiography remains the gold standard for assessing reperfusion in acute MI patients as per the 2016 AHA/ACC and 2017 ESC guidelines. However, in our setting, ST-segment resolution is the primary method for assessing the success of thrombolysis. It is widely accepted that the sensitivity and specificity of ST-segment resolution in detecting TIMI grade III flow are 94.79% and 67.69%, respectively, with 10-15% of patients showing total coronary artery occlusion despite successful thrombolysis (50% ST resolution).

Our study underscores that while ECG provides valuable insights into the success of thrombolysis, it may mask significant coronary artery occlusions. Therefore, earlier intervention, as per the ACC/AHA and ESC guidelines, is essential for timely detection and management of these occlusions.

CONCLUSION

Culprit artery total occlusion in successfully thrombolyzed patients, as determined by ECG, was more prevalent in elderly patients and those with delayed presentation. Early intervention and timely coronary angiography are recommended to optimize patient outcomes and further stratify treatment protocols.

AUTHORS' CONTRIBUTION

MA, JA, and KA: Concept and design, data acquisition, interpretation, drafting, final approval, and agree to be accountable for all aspects of the work. AA, SA, and AS: Data acquisition, interpretation, drafting, final approval and agree to be accountable for all aspects of the work.

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REFERENCES

1. Suthar N, Palat P, Masaraddi S, Patel M, Modi D. ST-segment resolution: a criterion of successful thrombolysis in acute myocardial infarction. Int J Cur Res Rev. 2014;06 (09):99-108.
2. Shah A, Wagner GS, Granger CB, O'Connor CM, Green CL, Trollinger KM, et al. Prognostic Implications of TIMI Flow Grade in the Infarct Related Artery Compared with Continuous 12-lead ST-Segment Resolution Analysis. J Am Coll Cardiol. 2000;35:666–72.
3. Shaikh MK, Shah SZ, Kumar C, Lohano M, Talpur AS, Zahoor A, et al. Accuracy of resolution of ST-segment elevation in electrocardiogram to determine the patency of infarct-related artery. Cureus. 2021;13(4):e14448.
4. Ranjana Mandal, Kiran Yadav. Assessment of ST Segment Resolution as a Predictor of Outcome in Acute Myocardial Infarction after Thrombolysis. Int J Cont Med Re. 2019;6(8):H1-H5.
5. Ryabykina GV, Sozykin AV, Dobrovolskaya SV. Comparative assessment of ECG dynamics in myocardial infarction according to reperfusion therapy approach (primary and facilitated coronary angioplasty) and timing of the procedure. Anatol J Cardiol. 2007:7 Suppl 1;171-4.
6. Arab TMA, Fouad AA, El Hammady WA, Zaki TM. Very Early versus Early Invasive Strategy after Successful Thrombolysis in Patients with ST-Segment Elevation Myocardial Infarction. J Cardiol Curr Res. 2016;7(5):00265.
7. Belle EV, Lablanche JM, Bauters C, Renaud N, McFadden EP, Bertrand ME. Coronary Angioscopic Findings in the Infarct-Related Vessel within 1 Month of Acute Myocardial Infarction Natural, History and the Effect of Thrombolysis. Circulation. 1998;97:26-33.
8. Gutiérrez-Barrios A, Cañadas-Pruaño D, Pino TB, Alba-Sánchez M, Ruiz-Fernández D, Calle-Perez G, et al. Early recruitment of coronary collateral circulation: impact in late presentation non re perfused acute coronary occlusion. Coron Artery Dis. 2018;29:550-6.

9. O'Gara PT, Kushner FG, Ascheim DD, Casey Jr DE, Chung MK, de Lemos JA, et al. 2013 ACCF/AHA guideline for the management of ST-elevation myocardial infarction: a report of the American College of Cardiology Foundation/American Heart Association Task Force on Practice Guidelines. J Am Coll Cardiol. 2013;61(4): e78-e140.
10. Salih Kilica, Cuneyt Turkoglu. Timing of Coronary Angiography After Successful Fibrinolytic Therapy in ST-Segment Elevated Myocardial Infarction. Cardiol Res. 2019;10(1):34-9.
11. Chotechuang Y, Phrommintikul A, Kuanprasert S, Muenpa R, Ruengorn C, Patumanond J, et al. GRACE score and cardiovascular outcomes prediction among the delayed coronary intervention after post-fibrinolytic STEMI patients in a limited PCI-capable hospital. Open Heart. 2020;7(1):e001133.
12. Saleem S, Khan A, Shafiq I. Post thrombolytic resolution of ST elevation in STEMI patients. Pak J Med Sci. 2016;32(1):201-5.
13. Ullah I, Bukhari AS, Durrani M, Khan Z,Tauqir S, Farid B, et al. Risk factors for ventricular tachycardia in acute ST-elevated myocardial infarction patients of a tertiary care hospital of Peshawar. J Rehman Med Inst. 2020;6(4):12-5.
14. Pu J, Ding S, Ge H, Han Y, Guo J, Lin R, et al. Efficacy and Safety of a Pharmaco-Invasive Strategy with Half-Dose Alteplase Versus Primary Angioplasty in ST-Segment-Elevation Myocardial Infarction: EARLY-MYO Trial (Early Routine Catheterization After Alteplase Fibrinolysis Versus Primary PCI in Acute ST-Segment-Elevation Myocardial Infarction). Circulation. 2017;136(16):1462-73.
15. De Lemos JA, Antman EM, Giugliano RP, McCabe CH, Murphy SA, de Werf FV, et al. ST-Segment Resolution and Infarct-Related Artery Patency and Flow After Thrombolytic Therapy. Am J Cardiol. 2000;85:299-304.
16. Khursheed M, Fayyaz J, Feroze A, Shakeel N, Bhatti JA. Time to treatment in patients of suspected acute coronary syndrome in Pakistan: a clinical audit. Heart Lung. 2015;44(1):63-7.
17. Rao K R, Reddy S, Kashyap JR, Ramalingam V, Dash D, Kadiyala V, Kumar S, Reddy H, Kaur J, Kumar A, Kaur N, Gupta A. Association of culprit lesion plaque characteristics with flow restoration post-fibrinolysis in ST-segment elevation myocardial infarction: an intravascular ultrasound-virtual histology study. Egypt Heart J. 2020;72(1):86. Erratum in: Egypt Heart J. 2020;72(1):88.
18. Guo Z, Yang X. Does pre-angiography Total ST-segment resolution reliably predict spontaneous reperfusion of the infarct-related artery in patients with acute myocardial infarction? BMC Cardiovasc Disord. 2019;19(1):264.
19. Girdhar R, Kothari Y, Raj RA, Shastry P, Kannadka C, Kenchappa K, et al. Successful or Unsuccessful Thrombolysis with Streptokinase in Acute Myocardial Infarction: A Descriptive Study. JMSCR. 2018:6(03):731-5.