

Frequency of Failure of ST-Segment Resolution after Primary Percutaneous Coronary Intervention in Patients with ST-Segment Elevation Acute Myocardial Infarction

MUHAMMAD RAHMAN KHALID¹, MUHAMMAD ADEEL QAMAR², ASHOK KUMAR³, RAJESH KUMAR⁴, MUHAMMAD OWAIS⁵, NAVEED AHMED SHAIKH⁶, TAHIR SAGHIR⁷, JAWAID SIAL⁸

¹Fellow cardiac imaging, Adult Cardiology NICVD Karachi

^{2,6}Post Fellow in interventional cardiology, NICVD Karachi

³Assistant Professor, (Adult Cardiology) NICVD Hyderabad

⁴Assistant Professor, NICVD Karachi

⁵Clinical fellow at NICVD Hyderabad

^{7,8}Professor, NICVD Karachi

Corresponding authors: Muhammad Rahman Khalid, Email: rahmankhalid@gmail.com

ABSTRACT

Objective: To determine the frequency of failure of ST-segment resolution after primary percutaneous coronary intervention (PCI) in patients with ST-segment elevation acute myocardial infarction (MI).

Methodology: This cross-sectional study was carried out at the CCU department of the National Institute of Cardiovascular Diseases (NICVD) Karachi, during six months from January 2017 to July 2017. All patients with ST elevation myocardial infarction admitted at CCC and undergoing primary PCI, the onset of typical pain of chest and related presentation in the last 12 hours that persists at least > 20 minutes, without the previous administration of fibrinolytic therapy assessed with history and previous reports, platelet glycoprotein IIb/IIIa inhibitors without prior administration and of either gender were included. All study subjects were shifted to Angiography department, the arterial sheath was inserted only through to the femoral route to prevent bias, and the interventional cardiologist with a minimum 05 years of professional experience was chosen. Angiography was performed, and the identified occlusion area was by interventional cardiologist ballooned/stented. ST resolution failure was seen after/within 30 minutes of primary angioplasty. All the information was collected via study proforma and SPSS version 26 was used for the data analysis.

Results: Mean age of the patients was 56.18±8.70 years, average BMI was 25.56±4.76 kg/m². Females were 25% and males were 77%. Complete resolution was achieved in 73% patients, while 22% patients Failure of ST-segment resolution post PPCI.

Conclusion: Our findings show that ST-segment resolution in the ECG within 30 minutes, as opposed to the traditional 90-min successful PPCI, is a significant predictive predictor. The intriguing discovery that ST-segment resolution has limited predictive value in a cohort of STEMI cases managed by the PPCI deserves additional exploration, especially as it is already widely used as the surrogate end point in trials.

Keywords: ST-Segment Resolution; Failure; ST-segment elevation myocardial infarction; primary percutaneous coronary intervention; electrocardiogram.

INTRODUCTION

Cardiovascular diseases (CVD) are the most common cause of mortality in the world, accounting for one-third of all death rates.¹ Over the last few years, significant progress has been made in the management of Acute Myocardial Infarction (AMI).² For patients with STEMI, there is currently a range of therapeutic options that are available to restore occluded coronary blood flow.³ The benefits of reperfusion therapy in acute myocardial infarction (AMI) have long been linked to the restoration of coronary flow in the artery that caused the infarction (ARI). Later, investigations with angiographic control indicated that, in addition to opening the ARI, achieving TIMI (Thrombolysis in Myocardial Infarction) grade iii flow was required to increase survival. Several investigations using magnetic resonance imaging, contrast echocardiography and gammagraphy have recently demonstrated that the stabilization of flow of the epicardial coronary does not always represent sufficient myocardial perfusion.⁴ In cases having ST-segment elevation MI, blood flow's rapid restoration in the thrombus-occluded coronary artery is a cornerstone of the treatment. Atherosclerosis is a long-term condition characterized by increasing cardiac injury whose rate is determined by the state of circulation in and around the affected area.⁵ Open artery hypothesis proposed in 1989 was corroborated by findings from several angiographic investigations showing a strong link between the patency of infarct linked artery and the progression of MI following reperfusion. Early flow restoration in IRA, according to this idea, has a significant effect on the amount of narcosis of cardia, left ventricular function, and hence the risk of early and late mortality.⁶ Percutaneous coronary and thrombolysis interventions are used to restore and maintain the patency of the coronary artery whose blockage caused ST-segment elevation MI. Nevertheless, the latter strategy has higher efficacy as measured by immediate and long-

term outcomes. The widespread use of these technologies in clinical practice has necessitated the development of accurate and, most probably, non-invasive ways for measuring treatment efficacy and predicting treatment outcomes. ECG recording is extremely useful for detecting arrhythmias and ST-segment changes, as well as providing vital information about the state of circulation of coronary artery and prognosis of the.⁷ ST-segment resolution failure Individuals having ST-segment elevation AMI have a survival rate of 27.9% after initial PCI.⁸ STEMI is a clinical condition characterized by myocardial ischemic symptoms.⁹ Acute ST-segment elevation MI is now treated with PPCI.¹⁰ Because the majority of cases do not present to a PCI-capable hospital, this provides a significant logistical difficulty in many areas.¹¹ According to a pooled meta-analysis, the absolute risk reduction for death from primary PCI was dependent on the participant's baseline risk.¹² Initial recanalization of an occluded coronary artery has become the primary goal in the treatment of acute MI. However, the degree of ST-segment resolution after PPCI (29 percent) in patients with STEMI had no effect on the LVEF (left ventricular ejection fraction), i.e. cardiac output.¹³ As a result, a significant number of cases continue to fail to achieve complete and sustained myocardial reperfusion. It is a growing source of concern in lower and the middle-income nations as risk factors like smoking and a higher BMI has become more prevalent around the world, and they are the main causes of death for both men and women everywhere. Nevertheless, because of the differences in body habits, dietary habits and environment, knowledge of ST-segment resolution failure in local population groups should be considered. As a result, in this study explored the correct magnitude of complications (failure of resolution) in local population groups. This study aimed to determine the frequency of ST-segment resolution failure after primary PCI in patients with ST-

segment elevation acute myocardial infarction in a public sector hospital.

MATERIAL AND METHODS

This cross-sectional study was conducted at the CCU department of the National Institute of Cardiovascular Diseases (NICVD) Karachi. The study duration was six 6 months from January 2017 to July 2017. All patients with ST elevation myocardial infarction admitted at CCC and undergoing primary PCI, the onset of typical pain of chest and related presentation in the last 12 hours that persists at least > 20 minutes, without the previous administration of fibrinolytic therapy assessed with history and previous reports, platelet glycoprotein IIb/IIIa inhibitors without prior administration (according to previous reports and history) and of either gender were included. Patients with NSTEMI as per operational definition, previous history of myocardial infarction, previous history of thrombolytic therapy, previous history of coronary angioplasty, previous history of coronary artery bypass grafting, patients with left bundle branch block as per record of patient, Prinz metal angina (previous history of cardiac chest pain less than 20 mints at rest that occurs in cycles), patients of cardiogenic shock at admission as per operational definition, COPD:(with history and pulmonary function tests), sepsis (with raised total leukocyte count), previous history of valvular heart disease (VHD):(on echocardiography), patient with deranged coagulation profile [Prothrombin time more than 10.5 and INR more than 1.0] (as per medical record) and patients who don't give consent of participation were excluded. Written informed consent was obtained from all patients or close relative. After the selection of the patient, they were shifted to Angiography department, however a radial path was available, the arterial sheath was inserted only through the femoral route to prevent bias, and an interventional cardiologist with minimum 05 years of professional experience was chosen. Angiography was performed, and the identifies occlusion area was by interventional cardiologist ballooned/stented. The study parameters ST resolution failure was observed and recorded after/within 30 minutes of primary angioplasty. All the data was collected via study proforma. and analyzed into SPSS version 26.

RESULTS

Patients average age was 56.18±8.70, mean BMI was 25.56±4.76 kg/m². Out of all 52% were males and 48% patients were females. Smoker patients were 55%, 64% were diabetic, 80% were hypertensive, dyslipidemia was in 61% patients, 70% presented with a BMI > 25kg/m². 68% patients were from urban population and 32% patients were from rural areas. Socioeconomically 44% were poor, 31% belong from middle class and 25% patients belong from upper class. Table.1

Table 1: Descriptive statistics of demographic characteristics (n=100)

Variables	Statistics	
Age	56.18±8.70 years	
BMI	25.26±4.76 kg/m ²	
Gender	Female	23 23.0%
	Male	77 77.0%
Smoking	Yes	55 55.0%
	No	45 45.0%
DM	Yes	64 64.0%
	No	36 36.0%
HTN	Yes	80 80.0%
	No	20 20.0%
Dyslipidemia	Yes	61 61.0%
	No	39 39.0%
BMI>25	Yes	70 70.0%
	No	30 30.0%
Residence	urban	68 68.0%
	rural	32 32.0%
Socio economic status	lower	44 44.0%
	middle	31 31.0%
	upper	25 25.0%

As per distribution of outcome ST-segment resolution failure, 78% patients have achieved complete resolution, while 22% patients have ST-segment resolution failure post PPCI. Fig:1

Stratification for ST-segment resolution failure was performed with respect to effect modifiers. Failure of ST-segment resolution was significantly linked to the age >50 years, smoking and rural residency (p<0.05), while failure of ST-segment resolution was statistically insignificant according to gender, diabetes, hypertension, dyslipidemia, BMI and socioeconomic status (p>0.05). Table.2

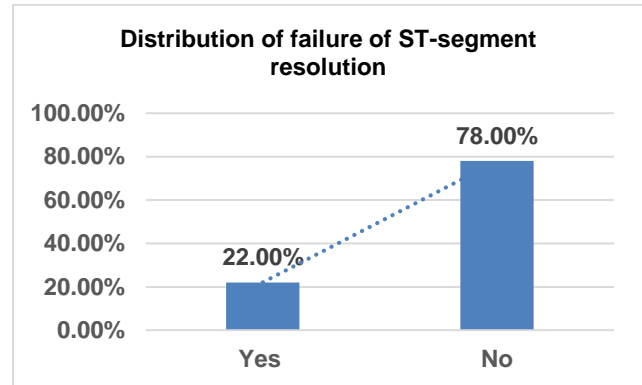


Fig 1: Distribution of ST-segment resolution failure (n=100)

Table 2: Stratification for ST-segment resolution with respect to effect modifiers (n=100)

Variables	ST-segment resolution failure		Total	P-value
	Yes	No		
Age	<50 years	5	38	0.003*
	≥50 years	22	35	
Gender	Female	17	31	0.07
	Male	10	42	
Smoking	Yes	23	32	0.002*
	No	4	41	
DM	Yes	15	49	0.35
	No	12	24	
HTN	Yes	20	60	0.40
	No	7	13	
Dyslipidemia	Yes	18	43	0.644
	No	9	30	
BMI>25	Yes	20	50	0.63
	No	7	23	
Residence	urban	13	55	0.015
	rural	14	18	
Socio economic status	lower	5	39	0.40
	middle	7	24	
	upper	5	20	

DISCUSSION

Regardless of the degree of patency of the target vascular, ST-segment resolution failure after the first PCI is highly associated with death and reinfarction. In this study, patient's average age was 56.18±8.70, mean BMI was 25.56±4.76 kg/m², 52% were males, smoker patients were 55%, 64% were diabetic, 80% were hypertensive, dyslipidemia was in 61% patients, 70% presented with BMI > 25kg/m², 68% patients were from urban population and socioeconomically 44% patients were poor. In the study of de Andrade, PB et al¹⁴ reported that the average of the patients was 58.8±10.8 years, average BMI was 28.0±4.6 kg/m², males were 55.7%, 68.9% cases were hypertensive, 31.1% were diabetes, and 39.3% were smokers. In the comparison of this study Park SR et al¹⁵ conducted a study on the outcome of cases underwent pPCI comparatively as incomplete STR (<70%) and complete STR (≥70%) and consistently in their study out of all study cases 79

were males and 22 were females. Furthermore, they found almost similar findings regarding mean age and frequency of diabetes, hypertension and smoking. In another study of et al¹⁶ demonstrated that the ECGs from 289 cases having STEMI were studied, and the average age of the participants was 63 years, with 74.7 % of men. Zhang Y et al¹⁷ also found comparable findings regarding age, gender and comorbidities in this study.

In this study as per ST-segment resolution failure, 78% patients achieved complete resolution, whereas 22% patients had ST-segment resolution failure post PPCI and Failure of ST-segment resolution was significantly linked to the age >50 years, smoking and rural residency ($p < 0.05$), whereas ST-segment resolution failure was statistically insignificant according to gender, diabetes, hypertension, dyslipidemia, BMI and socioeconomic status ($p > 0.05$). Consistently, Park SR et al¹⁵ reported that their findings showed that in 91 percent of cases, TIMI grade 3 recovery was achieved. Nevertheless, only 57 percent of all individuals could finish STR in the early stages. These findings confirmed that, despite effective PCI, a large proportion of patients with AMI following PCI have insufficient microvascular perfusion to cardiac tissue in the early stages of incomplete STR.¹⁵ Although Van der Zwaan HB et al¹⁸ demonstrated that out of 115 patients (52%) had early STR, while 9% had late STR. As a result, STR was obtained in 71% of individuals 30 minutes after arriving on the CCU. Cases with early and late STR had different baseline clinical and procedural characteristics: individuals with late STR were old aged, and TIMI flow post-PCI was worse in these individuals.¹⁸ Ndrepepa G et al¹³ in their study reported that the ST-segment resolution in electrocardiograms collected 90-120 minutes after PPCI beginning did not predict long-term mortality in STEMI cases undergoing PPCI. In compared to partial (30–70%) or no (30%) ST-segment resolution, complete (70%) resolution predicts lower 1–3-year mortality and lower incidence of cardiovascular potential complications, as well as greater maintenance of left ventricular function.^{19,20} Even after successful primary PCI, the benefits of early complete resolution of ST-segment elevation can be demonstrated, with early (i.e., immediately after PCI) testing being more accurate in terms of predicting CVD adverse events than evaluation after 90 minutes.^{19,21} Furthermore, patients who had early ST-segment resolution had a larger LVEF than those who had ST-segment resolution after 90 minutes. Higher peak creatine kinase levels and a higher incidence of severe LVSD were also found when complete ST-segment resolution was not achieved.^{19,22} As per previous published study, 86 percent of cases had TIMI flow grade III recovery after pPCI, and that low systolic BP, old age and the occurrence of blood clots in the culprit coronary lesions were independent predictive factors for TIMI flow grade III recovery.²³ STR has been shown to be a stronger predictive marker than epicardial blood flow recovery. As a result, STR in the early stages may be a useful marker for predicting the prognosis of AMI patients following PCI, and it must be evaluated after PCI.^{15,24} The main weakness of this study, besides the non-random sampling, was the limited sample size, which made it unable to uncover potential determinant variables for full ST-segment resolution failure after initial PCI.

CONCLUSION

The study findings show that ST-segment resolution in the ECG within 30 minutes, as opposed to the traditional 90-min successful PPCI, is a significant predictive predictor. The intriguing discovery that ST-segment resolution has limited predictive value in a cohort of STEMI cases managed by the PPCI deserves additional exploration, especially as it is already widely used as the surrogate end point in trials. Increased likelihood of having incomplete ST-segment resolution in older patients with anterior myocardial infarction and longer symptom onset-to-balloon time.

REFERENCES

- 1 Yusuf S. Effect of potentially modifiable risk factors associated with myocardial infarction in 52 countries. *Lancet* 2004;364:937–52

- 2 Weaver WD, Cerqueira M, Hallstrom AP, Litwin PE, Martin JS, Kudenchuk PJ, et al. Prehospital-initiated versus hospital-initiated thrombolytic therapy: the myocardial infarction triage and intervention trial. *JAMA* 1993;270:1211–6.
- 3 Lee KL. Predictors of 30-day mortality in the era of reperfusion for acute myocardial infarction. *Circulation* 1995;91:1659–68.
- 4 Domingo FP, Martínez JV, Domingo EP, Errazti IE, Herrero JV, Fernández EP, et al. Prognostic value of persistent ST-segment elevation after successful primary angioplasty. *Rev Esp Cardiol*. 2002 Aug;55(8):816–22.
- 5 Kloner RA, Ellis SG, Lange R, Braunwald E. Studies of experimental coronary artery reperfusion. Effects on infarct size, myocardial function, biochemistry, ultrastructure and microvascular damage. *Circulation*. 1983 Aug;68(2 Pt 2):18–15.
- 6 Pawlowska-Jenerowicz W, Lechowicz W, Dabrowski M. Favourable impact of acute myocardial infarction treatment by percutaneous coronary intervention on cardiovascular efficiency during one-year observation. *Post Kardiologii* 2006;2:199–206
- 7 Wijs W, Kolh P, Danchin N, et al. Wytyczne dotyczące reawaskularyzacji mięśnia sercowego. *Kardiologia* 2010; 68 supl. VIII: 569–638.
- 8 de Andrade PB, Rinaldi FS, Bergonso MH, Tebet MA, Nogueira EF, Esteves VC, et al. ST-Segment Resolution after Primary Percutaneous Coronary Intervention: Characteristics, Predictors of Failure, and 9. Impact on Mortality. *Revista Brasileira de Cardiologia Invasiva (English Edition)*. 2013;31;21(3):227–33.
- 9 Thygesen K, Alpert JS, Jaffe AS. Third universal definition of myocardial infarction. *Circulation*. 2012;126:2020–35.
- 10 Steg PG, James SK, Atar D. ESC guidelines for the management of acute myocardial infarction in patients presenting with ST-segment elevation. *Eur Heart J*. 2012;33:2569–19
- 11 Armstrong PW, Boden WE. Reperfusion paradox in ST-segment elevation myocardial infarction. *Ann Intern Med*. 2011;155:389–91.
- 12 de Boer SPM, Barnes EH, Westerhout CM, Simes RJ, Granger CB, et al. High-risk patients with ST-elevation myocardial infarction derive greatest absolute benefit from primary percutaneous coronary intervention: Results from the Primary Coronary Angioplasty Trialist versus Thrombolysis (PCAT)-2 Collaboration. *Am Heart J*. 2011;161:500–07.
- 13 Ndrepepa G, Alger P, Kufner S, Mehilli J, Schömig A, Kastrati A. ST-segment resolution after primary percutaneous coronary intervention in patients with acute ST-segment elevation myocardial infarction. *Cardiol J*. 2012 Jan 1;19(1):61–9.
- 14 de Andrade PB, Rinaldi FS, Bergonso MH, Tebet MA, Nogueira EF, Esteves VC, de Castro Bienert IR, de Andrade MV, Barbosa RA, e Mattos LA, Labrunie A. ST-segment resolution after primary percutaneous coronary intervention: characteristics, predictors of failure, and impact on mortality. *Revista Brasileira de Cardiologia Invasiva (English Edition)*. 2013 Jan 1;21(3):227–33.
- 15 Park SR, Kang YR, Seo MK, Kang MK, Cho JH, An YJ, Kwak CH, Hwang SJ, Jung YH, Hwang JY. Clinical Predictors of Incomplete ST-Segment Resolution in the Patients With Acute ST Segment Elevation Myocardial Infarction. *Korean Circ J*. 2009 Aug;39(8):310–316
- 16 Russhard P, Al Janabi F, Parker M, Clesham GJ. Patterns of ST segment resolution after guidewire passage and thrombus aspiration in primary percutaneous coronary intervention (PPCI) for acute myocardial infarction. *Open Heart*. 2016 Jun 1;3(1):e000430.
- 17 Zhang Y, Hui J, Chen X. Preprocedural Ticagrelor Treatment was Associated with Improved Early Reperfusion and Reduced Short-term Heart Failure in East-Asian ST-segment Elevation Myocardial Infarction Patients Undergoing Primary Percutaneous Coronary Intervention. *International Journal of General Medicine*. 2021;14:1927.
- 18 Van der Zwaan HB, Stoel MG, Roos-Hesselink JW, Veen G, Boersma E, von Birgelen C. Early versus late ST-segment resolution and clinical outcomes after percutaneous coronary intervention for acute myocardial infarction. *Netherlands heart journal*. 2010 Sep;18(9):416–22.
- 19 Fabiszak T, Kasprzak M, Koziński M, Kubica J. Assessment of Selected Baseline and Post-PCI Electrocardiographic Parameters as Predictors of Left Ventricular Systolic Dysfunction after a First ST-Segment Elevation Myocardial Infarction. *Journal of Clinical Medicine*. 2021 Jan;10(22):5445.
- 20 Farkouh ME, Reiffel J, Dressler O, Nikolsky E, Parise H, Cristea E, Baran DA, Dizon J, Merab JP, Lansky AJ, Mehran R. Relationship between ST-segment recovery and clinical outcomes after primary percutaneous coronary intervention: the HORIZONS-AMI ECG substudy report. *Circulation: Cardiovascular Interventions*. 2013 Jun;6(3):216–23.

- 21 Kumar S, Sivagangabalan G, Hsieh C, Ryding AD, Narayan A, Chan H, Burgess DC, Ong AT, Sadick N, Kovoor P. Predictive value of ST resolution analysis performed immediately versus at ninety minutes after primary percutaneous coronary intervention. *The American journal of cardiology*. 2010 Feb 15;105(4):467-74.
- 22 Schröder, R.; Wegscheider, K.; Schröder, K.; Dissmann, R.; Meyer-Sabellek, W. Extent of early ST segment elevation resolution: A strong predictor of outcome in patients with acute myocardial infarction and a sensitive measure to compare thrombolytic regimens. A substudy of the International Joint Efficacy Comparison of Thrombolytics (INJECT) trial. *J. Am. Coll. Cardiol.* 1995, 26, 1657–1664
- 23 An SG, Oh JH, Park TI, et al. Risk factors for reflow disturbance phenomenon during percutaneous coronary intervention in patients with acute myocardial infarction. *Korean J Med* 2008;74:16–22.
- 24 Matetzky S, Novikov M, Gruberg L, et al. The significance of persistent ST elevation versus early resolution of ST segment elevation after primary PTCA. *J Am Coll Cardiol* 1999;34:1932–1938.