

## ARTICLE

ECHOCARDIOGRAPHIC EVALUATION OF PATIENTS WITH  
PERSISTENT ST SEGMENT ELEVATION AFTER SUCCESSFUL  
PRIMARY ANGIOPLASTYMohsen Mohebati<sup>1</sup>, Bentolhoda Panjalizadeh<sup>2\*</sup><sup>1</sup>MD Cardiologist, associated professor of cardiology, Department of Cardiology, Faculty of Medicine, Mashhad University of Medical Sciences, Mashhad, IRAN<sup>2</sup>MD Resident of Cardiology, Department of Cardiology, Faculty of Medicine of Mashhad University of Medical Sciences, Mashhad, IRAN

## ABSTRACT



**Introduction:** Percutaneous intervention [PCI] is an accepted method of reperfusion in patients with acute ST segment elevation myocardial infarction [STEMI]; resulting in better left ventricle function and increase in life expectancy. However, if PCI fail to completely recover ventricular function, mortality and left ventricular failure may increase. Establishing coronary blood flow in angiography is not always indicating proper cardiac circulation and cardiac events may occur later in life. There are many factors related to patient's outcomes after primary PCI. ST segment resolution is one this factors which is noninvasive and indicates reperfusion. However, the relation between ST segment changes and echocardiographic findings is not widely studied. The aim of present study is evaluation of electrocardiography [ECG] and echocardiography finding in post STEMI patients undergoing PCI. **Material and methods:** one hundred and seventy patients who had STEMI and underwent successful PCI were chosen by convenience sampling and enrolled in this study. After considering exclusion criteria, every patient had 12 lead ECG 60min, 90min, 120min, 1st day and 2 month after PCI. Also, a transthoracic echocardiography [TTE] was performed after PCI, and 2 more TTE were performed day after and 2 months after PCI. ST segment resolution was evaluated in every ECG and the results were compared with TTE findings. **Results:** Mean±SD of time duration between onset of symptoms and calling EMS [OSCE], door to balloon time [DTB], time duration between first medical staff visit and angioplasty [FMVA] were 103.4±56.63 min, 35.58±4.43 min and 60.58±4.43 min respectively. **Conclusion:** In-hospital and pre-hospital delays are two prominent findings in our study which were related to inappropriate ST segment resolution after successful PCI in STEMI patients. Also, patients with Anteroseptal and anteroseptolateral MI will show lesser ST segment resolution

## INTRODUCTION

Cardiovascular diseases are major cause of mortality world wide. The mortality rate has showed 40.8% increase from 1990 to 2013 despite of decrease in deaths attributed to epidemiologic changes [1]. By recent development diagnosing and managing cardiovascular disease, mortality rate from these disease is reducing in some regions such as some European countries which have reported median annual reduction of case fatality rate around 5% [2]. Myocardial infarction [MI] is a severe manifestation of cardiovascular disease. The incidence rate of MI in Iran is reported to be 73.3 per 100000 which is higher than some Arab countries in middle east [3]. Acute MI is divided into 2 main categories according to ST segment appearance on electrocardiography [ECG] as ST elevation MI [STEMI] and non ST elevation MI [NSTEMI]. The end feature of MI is myocyte necrosis and will lead to ventricular function disruption [4]. In patients with STEMI, complete total occlusion is usually seen and reperfusion is needed to be established with 60 to 90min [4]. Early results of successful angiography shows improved left ventricular function and increased patient's survival. While there are some non-invasive markers suggested for assessing reperfusion, these results are compared mostly with angiography results [5, 6]. Angiographic assessment is based on thrombolysis in myocardial infarction [TIMI] in infarct related artery. While primary angioplasty mostly lead to early and complete reperfusion; however, reopening of coronary vessels doesn't indicated successful reperfusion [5-7]. An angiographic snapshot of blood flow through the infarcted myocardium will not guarantee later intact coronary microvasculature [8]. There are many imaging techniques available for detecting myocardial perfusion defects such as cardiac magnetic resonance imaging [CMR] and Echocardiography [9, 10]. However, there are less expensive and widely used techniques for determining reperfusion injury such as ECG is available which requires more attention of researchers [11]. Myocardial perfusion defects, which are predictable from ECG, are significantly different from angiographic findings of TIMI 3 in an infarct related artery. This fact challenges the concept that TIMI grade 3 flow is a sufficient indicator of reperfusion. Approximately one third of acute MI patients shows impaired micro vascular reperfusion after successful recanalization [11]. Persistent ST segment elevation shortly after successful recanalization is thought to be related with sustained trans-mural injury [11]. ST segment monitoring after primary PCI is a simple and validated method for assessing adequate myocardial perfusion. The resolution is correlated with restoration of blood flow and myocyte function. As well as determining reperfusion, ST resolution is related to mortality rate of patients [12]. Also, ST segment resolution is thought to be related with ejection fraction but not widely studied. Recently, Hallen et al. reported that left ventricular ejection fraction is only related to sum ST segment deviation resolution in 90min after PCI. [13]. ST segment resolution is related to cardiac ejection fraction in different times. Present research tried to find any

## KEY WORDS

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## \*Corresponding Author

Email:  
panjalizb931@mums.ac.ir  
Tel.: +989155683036  
Fax: +985138544504

relation between ST segment changes after successful PCI of STEMI patients and their echocardiographic features as an indicator of cardiac global function. The aim of this study is Echocardiographic evaluation of patients with persistent ST segment elevation after successful primary angioplasty.

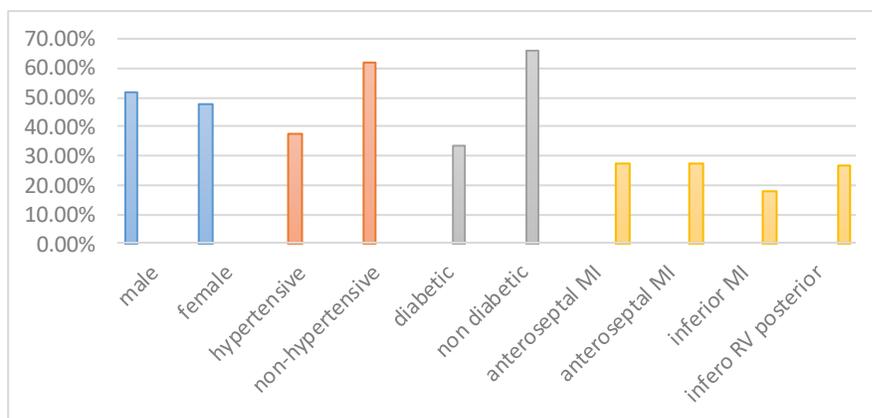
## MATERIAL AND METHODS

Present case control study was approved by Mashhad University of Medical Sciences research and ethic committee and conducted on patients who were referred to cardiology department of Ghaem hospital in Mashhad, Iran. Patients with the impression of STEMI were chosen by convenience sampling. Those who had cardiac pain for more than 12 hours before admission, had severe renal insufficiency, their angioplasty results were other than TIMI 3, had cardiopulmonary resuscitation before angioplasty, had history of open heart surgery or angioplasty, previous history of MI, heart failure and severe concomitant valvular disease were excluded from this study. After performing a transthoracic echocardiography by a cardiologist, every patient underwent PCI and infarct related artery flow was evaluated. Response to PCI was evaluated by ECG of 60min, 90min, 120min, one day and 2 months after PCI. No response was considered as depression lower than 30%. Also, participants underwent transthoracic echocardiography before hospital discharge and 2 months after.

Characteristics of participants will be presented using descriptive statistics including measures of central tendency, frequency and distribution in the form of appropriate tables and figures. Then, cardiac function and ejection fraction will be presented as continuous variable using mean and standard deviation. The Chi-square test will be used for the statistical analysis for categorical variables. The student t-test will be used for continuous variables in case of normal distribution while the Mann-Whitney test will be used for comparison of non-normally distributed variables.

## RESULTS

One hundred and seventy patients [mean±SD:49.96±3.16 years- ranging between 35 to 65 years old] who have successfully underwent angiography were enrolled in present study. Most of the patients were male [52.4%]. Mean±SD of low density lipoprotein [LDL], cholesterol, triglyceride and high density lipoprotein [HDL] level were 121.14±18.53 mg/dl, 196.4±20.01 mg/dl, 190.06±18.58mg/dl and 37.26±6.99 mg/dl respectively. Other descriptive statistics of discrete demographic variables are summarized in [Fig. 1]. Mean±SD of time duration between onset of symptoms and calling EMS [OSCE], door to balloon time [DTB], time duration between first medical staff visit and angioplasty [FMVA] were 114.4±56.63 min, 35.58±4.43 min and 60.58±4.43 min respectively. Mean ejection fraction and systolic volumes were showed an increasing pattern during the study period [Table 1]. Delayed referral in different stages were significantly related to ejection fraction and systolic volume which is summarized in [Table 2]. Hypertensive patients had lower systolic volume [P=0.000] and patients with hypercholesterolemia had higher systolic volume at the time of admission and at the end of first day [P=0.024]. Also, Inferior and inferoRV posterior MI had significantly higher ejection fractions at the end of first day and second month [p=0.000 for both]. Meaningful relations between ST segment resolution indifferent stages and echocardiographic findings are summarized in [Table 3].



**Fig. 1:** Descriptive statistics of discrete demographic variables [MI: myocardial infarction, RV: right ventricle].

**Table 1:** Patient's descriptive features

Age	49.92	±	0.242
HDL	37.34	±	0.53
LDL	119.38	±	1.46
TG	190.45	±	1.44
cholesterol	194.81	±	1.51
SYMtoEMS	133.15	±	4.02
DtoDtime	36.15	±	0.35
FMCtoDtime	61.15	±	0.35

**Table 2:** Patient's echocardiographic features

		ESV	EF
age	Pearson Correlation	-.029	-.018
	p-value	.590	.745
HTN	Pearson Correlation	.037	.089
	p-value	.499	.101
High LDL	Pearson Correlation	.037	.026
	p-value	.498	.634
High TG	Pearson Correlation	-.032	-.060
	p-value	.553	.272
hypercholesteolemia	Pearson Correlation	.026	.012
	p-value	.627	.827
Time from symptom onset to callEMS	Pearson Correlation	-.156**	-.313**
	p-value	.004	.000
Door to device time	Pearson Correlation	-.071	-.060
	p-value	.194	.270
First medical contact to device time	Pearson Correlation	-.071	-.060
	p-value	.194	.270

**Table 3:** Meaningful relation between ST segment resolution and echocardiographic variables

		p-value			p-value				
Sex	Man	9.79	±	.206	1.000	8.33	±	.202	0.803
	Woman	9.89	±	.145		8.65	±	.194	
DM	Yes	9.68	±	.155	0.875	7.78	±	.253	0.002

	No	9.92	±	.176		8.84	±	.164	
HTN	Yes	9.73	±	.27	1.000	8.19	±	.232	0.74
	No	9.91	±	.123		8.67	±	.175	
MI	Anteroseptal	9.94	±	.205	0.989	6.51	±	.212	<0.001
	Anteroseptolateral	9.92	±	.194		8.30	±	.253	
	Inferior	9.49	±	.477		10.38	±	.298	
	Inferiorvposterior	9.89	±	.208		9.43	±	.201	

Ejection fraction [EF], systolic volume [SV], transthoracic echocardiography [TTE].

## DISCUSSION

Successful PCI in most cases is not the end point of complete reperfusion. While there are other imaging techniques introduced for assessing reperfusion, other noninvasive and widely available monitoring techniques such as 12 lead ECG is considered to be helpful. ST segment resolution after successful PCI is an indicator of cardiac function in future which takes effects from other modalities such as possible delays in establishing reperfusion and previous medical condition.

Over past few years, still there is approximately a 2 hours duration between initiation STEMI symptoms and seeking medical care. This duration is shorter for patients who are directly transferred to hospital by emergency medical services[EMS][5]. This delayed referral is mostly due to patient's previous bias from a heart attack. Most of patients think that heart attack is dramatically characterized by severe crushing left sided chest pain[5]. Considering the pain a self-limited or not serious, attempting for self-treatment and not knowing the importance of immediate action and calling EMS are other possible reasons for late referral[5]. According to the latest American heart association guideline for management of patients with STEMI, door to balloon time lesser than 90min and door to needle time lesser than 30min is recommended for centers with capability of performing PCI[5]. Also, first-medical-contact-to-balloon optimal time is reported to be less than 90min[14]. The multicenter study by Kassaian et al. was the first study on management of patients with ACS syndrome in our country who followed their patients for one year [15]. Composition of Iranian patients with ACS according to their ACS type is most likely similar to developed European countries and different from developing countries of Africa and Middle East [15]. According to their study, Iranian physicians are treating ACS patients highly in adherence with guideline recommendation for in-hospital management but underuse dual antiplatelet therapy at discharge [15]. Iranian patients with STEMI are more likely to be presented to hospital lately. However, in hospital reperfusion therapy of these patients is quite appropriate [15]. In our study the mean time between initiation of symptoms and calling EMS was lesser than Kassaian et al. study. Also, the mean door needle and door to balloon time was 45.6 and 82.9 min respectively in Kassaian et al. study which is greater than our study [15]. Uncertainty of diagnosis, presence of other medical life threatening conditions or delays in filling and understanding the informed contests are possible factors increasing in hospital delays [5]. While reducing in-hospital delays seem difficult, educating the patients and their families will be the first and most important step in reducing the pre-hospital delay. By introducing all possible signs of heart attack, even if patients didn't take their symptoms seriously, their family members will encourage them for seeking prompt medical care.

There are various techniques reported for evaluation of cardiac reperfusion and remodeling. Farag et al. study evaluated cardiac remodeling after PCI by using echocardiography in 232 patients with STEMI. They defined cardiac remodeling as 20% increase in left ventricle end diastolic volume after six months. Symptoms to balloon time and symptoms to door time were both significant predictor of left ventricle remodeling. This findings highlights the lack of awareness about myocardial infarction symptoms and the necessity of in-time referral[16].

CMR is new imaging technique which will provide important information such as infarct size, micro vascular obstruction, myocardial salvage index and left ventricle ejection fraction which are all incremental prognostic value in patients with STEMI [10]. Nguyen et al. found that infarct scar site is an important prognostic factor for diastolic remodeling after STEMI. They evaluated their patients by serial

transthoracic echocardiography and cardiac magnetic resonance imaging [CMR] at median of 4 and 55 days after STEMI. Larger infarct scar site following STEMI results in adverse diastolic remodeling and emphasis a larger group of at risk patients. Their finding revealed an important link between myocardial damage and serially evaluated diastolic function [17].

Lenz et al. introduced real time myocardial perfusion echocardiography as a noninvasive bedside technique for evaluation of major adverse cardiac events in patients with STEMI [9]. They compared CMR infarct mass and real time myocardial perfusion echocardiography in 27 patients after early reperfusion. Myocardial blood flow and infarct mass after adjusting risk factors were independent predictors of major cardiac events [9].

Despite of CMR and real time myocardial perfusion echocardiography, 12 lead ECG is still an inexpensive and easily applicable tool for assessing cardiac condition after PCI. ST segments changes are also used for evaluation of myocardial reperfusion. These changes can be considered as a reliable non-invasive marker for cardiac reperfusion [6, 7]. Sanati et al. reported that time from onset of symptoms to initiation of catheterization is significantly related to magnitude of ST segment resolution[18]. Delay in performing PCI will result in higher rate of reperfusion failure and lead to adverse clinical outcome. Their median of presentation time were 3,5 and 5.5 hours for patients with complete, partial and no resolution respectively. They also concluded that involvement of left anterior descending artery is associated with poorer myocardial reperfusion after successful PCI. Also in our study, Anteroseptal and anteroseptolateral MI showed poorer ST segment resolution. More degree of ST resolution will be achieved if right coronary artery is treated as culprit artery[18]. They explained this finding according the ability of right ventricle in handling ischemia[18]. Jiecheng et al. study evaluated long term effect of early and subsequent no-reflow phenomenon after PCI in 420 patients with STEMI. They reported that in early no-reflow patients despite of severe baseline angiographic and clinical characteristics, poorer long term prognosis, lower left ventricular ejection fraction and larger left ventricular end diastolic diameter is prominent[19].

## CONCLUSION

In-hospital and pre-hospital delays are two prominent findings in our study which were related to inappropriate ST segment resolution and lower ejection fraction after successful primary PCI in STEMI patients. Also, patients with Anteroseptal and anteroseptolateral MI will show lesser ST segment resolution.

### CONFLICT OF INTEREST

There is no conflict of interest.

### ACKNOWLEDGEMENTS

None

### FINANCIAL DISCLOSURE

None

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