Original Article

Prediction of the Culprit Artery in Patients with STEMI Undergoing Primary Angioplasty at Rajaie Hospital

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ABSTRACT

Background: In ST-elevation myocardial infarction (STEMI), the use of ECG in the acute phase contains useful information, including the lesion location, and it contributes to the appropriate treatment. We sought to evaluate the culprit artery in patients with STEMI through ECG variations and its relation with the culprit lesion identified on angiography.

Methods: Patients referring to Rajaie Cardiovascular, Medical, and Research Center between September 2011 and September 2012, due to acute MI accompanied by STEMI were chosen. Based on the ECG, the culprit artery was determined and the amount of ST-elevation in every lead was recorded. On angiography, the exact location of the closure in the main coronary vessels and/or side branches was identified. The findings were adjusted to the ECG, and its ability in the prediction of the culprit lesion was assessed.

Results: We studied 100 patients, comprising 17 female and 83 male patients, at an average age of 57.64±11.31 years. The introduced model of ECG was useful for the prediction of the lesion in the proximal right coronary artery (RCA), mid left anterior descending artery (LAD) before D1 after S1, and proximal LAD and the least predictive ability was for the distal LAD and the distal RCA. The relationship between the proximal LAD and ST-elevation >2.5 mm in V1 was significant, and the relationships between the mid LAD before D1 after S1 and QAVL, Q in V4-V6, ST-depression >1 mm in III and no ST-depression in II and AVF were significant as well.

Conclusions: Our results demonstrated that in patients with STEMI, ECG was able to reliably predict the location of the culprit lesion in most vessels such as the proximal RCA and the mid LAD before D1 after S1. ***(Iranian Heart Journal 2016; 17(1): 6-13)***

Keywords ■culprit artery ■ STEMI ■ ECG ■ Lesion ■Angiography

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Coronary artery diseases, especially acute coronary syndromes, are the most common and the most important cause of mortality in most societies.[1-2] Myocardial infarction (MI) is regarded as the fatal indicator of heart diseases,[3] with 1 of 5 deaths being due to acute coronary diseases.[4] MI infarction causes an increase in hospitalization costs and long-lasting disabilities and mortality.[6] Hospital mortality due to MI used to be about 30%. It has been considerably decreased to between 8% and 10% during the past decade, which can be attributed to the utilization of extensive preventive strategies in society such as the use of thrombolytic medications, aspirin, and beta-blockers or early angioplasty. The establishment of coronary care units has decreased heart failure mortality from 30% to 19%.[6-8] One of the most critical examinations is ECG, which divides patients with MI into 3 categories:

1. Patients with acute MI, accompanied by ST-elevation (STEMI)
2. Patients with unstable angina
3. Patients with acute MI without ST-elevation (non-STEMI)

Particularly, ECG provides us with precise information regarding the culprit artery. In the preliminary stages of examination, this can be of great help. We evaluated ECG variations and their relationship with diagnosed lesions on angiography during the acute phase of MI in patients who referred to Rajaie Cardiovascular, Medical, and Research Center.

METHODS

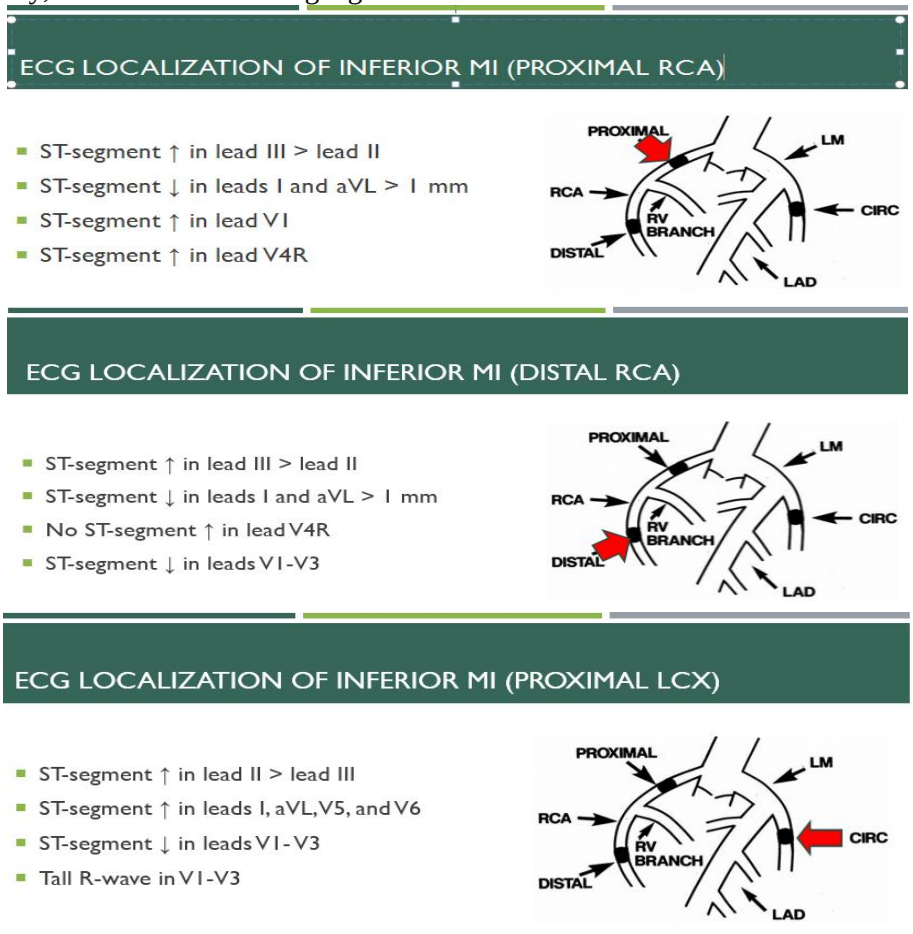
We studied patients who referred to Rajaie Cardiovascular, Medical, and Research Center due to STEMI between September 2011 and September 2012. ECG leads in which there was ST-elevation were identified. Then, based on the ST-segment and by making use of the other ECG findings, the culprit artery and the extent of the ST-elevation in each of the leads were determined. The patients' angiographic findings were evaluated and the exact location of the closure in the coronary artery, the stenosis intensity, and thrombolysis in myocardial infarction (TIMI) flow of the involved vessel were determined. Thereafter, angiographic findings were adjusted to the ECG to determine its ability to determine the culprit lesion. Also, the relationships between other variables such as age, gender, coronary vessel disease risk factors, enzymatic markers, and echocardiography findings and ECG and angiography were investigated.

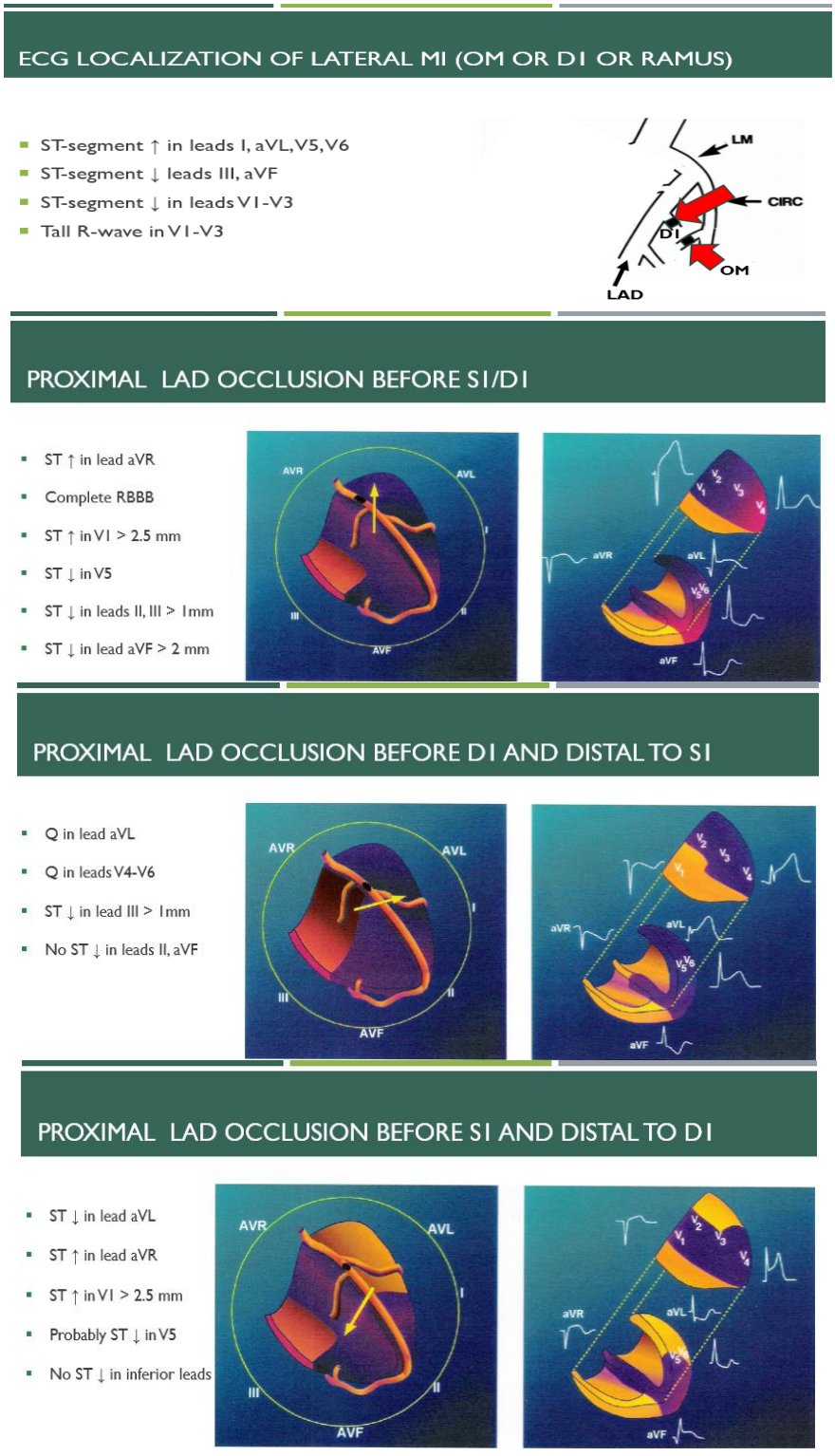
The data obtained were logged into SPSS, version 15. The discrete data are expressed in the form of frequencies, and the continuous data are expressed as means ± SDs. The chi-square tests were used to compare the discrete data, and regression tests were utilized to evaluate the relationship between the 2 methods and the Cox and Snell test was employed to study the prediction value. An $\alpha < 0.05$ was considered significant.

Variables

Variable Name	Independent	Dependent	Quantitative		Qualitative		Scientific Definition	Measurement Style	Scale
			continuous	discrete	nominal	ranking			
Age	*		*				Years of age	ID card	Y
Gender	*				*		Patient's phenotype	Patient's appearance	Male/Female
Cardiovascular diseases risk factors					*		Hypertension, Dyslipidemia, smoking diabetes, positive family history	File evaluation	Has/ Does not have
Ejection fraction			*				LV systolic performance	Echocardiography	Percent
ST-elevation			*				ST-elevation in relation to Isoelectric line	ECG	Percent
Culprit artery				*			The determination of the main involved vessel	Angiography	Vessel type
Culprit lesion					*		The involvement style	Angiography	Percent
Troponin			*				Protein of the heart muscle texture	Experiment	Microgram
ST-depression				*			ST-depression amount relative to Isoelectric line	ECG	Percent
Q-wave				*			The ventricle's activity marker	ECG	Millimeter
TIMI				*		*	0=non-perfusion, 1=penetration no perfusion, 2=delay perfusion, 3=normal	Angiography	Grade

In the current study, we used the following algorithm[10]:





RESULTS

In the present study, 100 patients, consisting of 17 female and 83 male patients, at an average age of 57.64±11.31 years were evaluated. Fifty percent of the patients had hypertension, 31% diabetes, 12% dyslipidemia, and 12% were diagnosed with a family history of coronary artery diseases. Additionally, 54% of the study population

were smokers. The most common risk factor was smoking.

Among the 100 patients studied, 93% had TIMI flow between 0 and 1 and in about 59% of the patients, the stenosis diameter was >70%. The most prevalent ECG finding among the patients was 2.5 mm ST-elevation in V1 followed by ST-elevation in III>II (23%).

Angiography revealed that the most common involved vessel (28%) was the proximal right coronary artery (RCA) followed by the proximal left anterior descending (LAD) (26%).

The frequency of the culprit lesion location was maximum (28%) in the proximal RCA, followed by the proximal LAD (26%) and the distal LAD. The distal RCA had the lowest frequency.

The relationship between the angiographic findings and ECG indicated that the relationship between the proximal LAD and ST-elevation in V1 >2.5 mm was significant and the relationship between mid LAD before D1 after S1 and Q in AVL, in V4-V6, ST-depression >1 mm and no ST-depression II and AVF was significant and the relationship between mid LAD before S1 after D1 and ST-elevation in AVR and ST-elevation in V1>2.5 mm was also significant. Also, the relationship between the proximal RCA and ST-depression in AVL >1 mm and ST-elevation in II<III and also the relationship between the distal RCA and no ST-elevation in V4R was significant as well.

Angiography	ECG	B	P value
Proximal LAD	ST elevation AVR	-0.44	0.68
	RBBB	-2.01	-
	ST elevation V>12.5	3.64	0.003
	ST depression V5-V6	-1.14	-
	ST depression II-III1	23.14	0.99
	STdepressionAVF2	1.76	-
Mid LAD before D1	Q AVL	-1.51	0.001
	QV4-V6		0.001
	ST depression III 1		0.001
	No ST depression II AVF		0.001
Mid LAD Before S1	ST elevation AVR	1.69	0.001
	ST elevation V12.5	2.15	0.001
	ST depression AVL	2.30	0.001
	No ST depression inferior	5.11	0.001
Distal LAD	ST depression AVL	3.77	-
	QV4-V6	34.53	0.99
	No ST depression inferior	31.13	0.99
Proximal RCA	ST elevation IIIII	2.04	0.31
	ST elevation V1	22.43	0.99
	ST elevation V4R	21.43	0.99
	ST depression I AVL1	4.76	0.003
Distal RCA	ST elevation II-III		0.009
	ST depression I AVL1		0.28
	No ST elevation V4R		0.001
	ST depression V1-V3		0.041
Proximal LCX	ST elevation II-III_A	41.62	0.99
	ST elevation I AVLV5-V6	0.37	-
	ST depression V1-V3	-0.04	-
	Tall RV1-V3	20.87	0.99
OM diagonal ramus	ST elevation I AVLV5-V6	20.31	0.99
	ST depression V1-V3	0.28	0.87
	Tall RV1-V3	-0.09	0.96
	ST depression III AVF	1.77	0.29

LAD, Left anterior descending; RCA, Right coronary artery, OM, Obtuse marginal

The Cox and Snell R square indicated that the presented ECG model was more advantageous for the prediction of the proximal RCA and the mid LAD before D1 after S1 and the proximal LAD, and the current model was considered appropriate and significant since between 57% and 64% of the responses were accounted for by the predictor variables. The least reliable prediction related to the distal LAD and the distal RCA, and the presented model was not considered significant and appropriate in such cases.

Cox and Snell R Square

Proximal LAD	0.57
Mid LAD before D1	0.61
Mid LAD before S1	0.45
Distal LAD	0.10
Proximal RCA	0.64
Distal RCA	0.17
Proximal LCX	0.30
OM diagonal ramus	0.24

LAD, Left anterior descending; RCA, Right coronary artery, LCX, Left circumflex; OM, Obtuse marginal

The relationship between ST-elevation and age and the amount of troponin was not significant, but the amount of the mutated fraction and ST-elevation extent had an inverse, significant relationship.

There was a significant relationship between age and lesion, but there was no significant relationship between the lesion and hypertension or diabetes or smoking or dyslipidemia or family history.

DISCUSSION

Previous studies have indicated that the 12-lead ECG is a useful method for the determination of the location of STEMI and ST-elevation analysis is advantageous in ECG leads for the determination of the location of the involved vessel. Generally, the more proximal the closure position, the more intensified the MI. The first measure in such cases is to record an ECG, which can be of great help for the diagnosis of the damaged vessel and the lesion position.[10-14] Nonetheless, the question which motivated us to perform this study was to what extent ECG indices are correlated with their golden standard, namely angiography, for predicting the involved vessel. From the 100 patients evaluated in the present study, 93% had TIMI flow between 0 and 1 and about 59% of the patients had >70% vessel stenosis. The most prevalent ECG finding among the patients was ST-elevation in V1>2.5 mm (27%), followed by ST-elevation in III>II (23%). The frequency of the angiographic findings of the patients revealed that the most common involved vessel was the proximal RCA (28%), followed by the proximal LAD (26%). Nevertheless, contrary to our findings, previous studies have shown that the most common involved vessel is the LAD, followed by the RCA.[12] In the angiographic evaluations of the patients, the frequency of the culprit lesion position was highest (28%) in the proximal RCA, followed by the proximal LAD (26%), and it was lowest in the distal LAD and the distal RCA. The relationship between the proximal LAD and ST-elevation in V1>2.5 mm was significant, the relationship between after S1 mid LAD before D1 and Q in AVL, Q in V4-V6, no ST-depression in II and AVF and ST-depression in III>1 mm was significant, the relationship between after D1 mid LAD before S1 and ST-elevation in AVR, ST-elevation in V1>2.5 mm, ST-depression in AVL, and no-ST-depression in the inferior leads was significant as well. Also, the relationship between the proximal RCA and AVL-ST-depression in I and ST-elevation in III>II and the distal RCA and no ST-elevation in V4R was significant as well. Generally, our study indicated that the presented model was the most appropriate for the prediction of the proximal RCA and mid LAD before D1 after S1 and the proximal LAD since between 57% and 64% of the responses could be accounted for by the predictor variables and the lowest extent goes to the distal LAD and the distal RCA. Studies on ECG findings in patients with ST-elevation have shown contrasting results. One study which evaluated patients

with lower and anterior MI indicated that sensitivity of 63% and specificity of 100% could be achieved regarding LAD closures and sensitivity of 67% and specificity of 82% were achievable for the RCA in ECG. A study showed that in patients with anterior MI in the angiographic evaluation of the proximal or distal LAD closure, ECG sensitivity was 77% and 88%, respectively, and specificity was 77% and 82%, correspondingly.[15] Also, another study on patients with acute anterior MI in which there was ST-elevation in V1>2.5 mm lead and right bundle branch block was completely existent, ECG had 100% specificity in the evaluation of the culprit lesion in the LAD.[16] Another study on patients subjected to ECG antecedent to reaching the hospital revealed that taking a 12-lead ECG was a reliable measure for the evaluation of the culprit coronary lesion.[11] Another study reported that the specificity of ECG in indicating the culprit artery in patients with MI coexistent with ST-elevation was 90%.[12] Also, there are 2 other studies which have shown that ST-segment depression in the AVR lead could be a reliable indicator of the culprit artery and also the infarct size in patients with inferior STEMI.[13,14] Meanwhile, it is worthy of note that the results of the studies performed previously are not always compatible. For instance, one study in Iran indicated that ECG in patients with ST-elevation did not lend itself to a good and acceptable prognostics.[10] Another study, also, reported that MI, structural factors, and heart anatomy were relevant to the results obtained. One study showed that factors such as left coronary prevalence, multi-vessel involvement, and not observing the proximal culprit lesion in ECG led to defectiveness in the culprit artery diagnosis in lower MI in the 12-lead ECG.[17] In the present study, 50% of the patients were diagnosed with hypertension, 31% with diabetes, and 54% with smoking. The most common risk factor was smoking. The relationship between ST-elevation and age and troponin was not significant, while mutated fraction and ST-elevation were in an inverse, significant relationship. The relationship between age and the lesion was significant, but the relationships between the lesion, hypertension, diabetes, smoking, dyslipidemia, and family history were not significant. Furthermore, the relationships between TIMI flow and gender, diabetes, smoking, dyslipidemia, and family history were not significant. The relationships between age and the mutated fraction and the lesion were not significant as well. Moreover, the relationship between troponin and ST-elevation and the lesion was not significant. Additionally, the relationship between TIMI flow and troponin and ST-elevation was not significant.

In a nutshell, the studies performed are indicative of this finding that the 12- lead ECG is a proper method in the prognosis of the culprit artery in STEMI and its utilization has been recommended in patients diagnosed with such diseases. Our study also confirms these results in the prediction of the culprit artery in the RCA and the LAD.

The most important limitation of our study was the low sample volume, which reduces our ability to generalize the results. However, one of the strong points of our study is that it was performed in a referral center, affording us patients with a great deal of diversity; the results are, therefore, indicative of an extensive spectrum of the Iranian society.

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