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Electrocardiographic localization of infarct related coronary artery in acute inferior wall ST elevation myocardial infraction and in hospital outcome in tertiary cardiac care center

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Abstract

Background: In addition to diagnosing the acute ST Elevation MI stratifying (STEMI) high-risk patients and proper treatment strategies are important issues in managing patients. The goal of this study was to determine the relation of ST segment changes in Electrocardigram with the site of occlusion in vessel , to evaluate the prognostic value of ST segment deviation in aVR and its role in identification of Infarct Related Artery (IRA) in patients with acute inferior myocardial infarction.

Methods: The study included 56 patients with acute inferior wall STEMI. All patients underwent Coronary Angiogram. Patients were divided into two groups based on the IRA and were followed up during their hospital stay for complications.

Result: The culprit artery was Right Coronary Artery (RCA) in 40 patients (71.4%) and Left Circumflex Artery (LCX) in 13 patients (23.2%). Study showed 92% sensitivity, 80% specificity for predicting RCA related infarction with ST elevation lead III > lead II and 83% sensitivity ,90% specificity for (LCX) with ST elevation lead II > lead III . The overall in-hospital mortality was 3.5%.

ST depression in aVR was associated with 87.5% specificity and 83% sensitivity in diagnosing LCX as the Infarct Related Artery (IRA). The in-hospital mortality rates for patients with ST segment deviation in aVR (20 patients) and no ST segment changes (36 patients) were 5% and 2.7% respectively.

Conclusion: In addition to the conventional ECG criteria for identifying culprit vessel, lead aVR may be useful in clinical practice when assessing patients with inferior STEMI and with poor in-hospital outcome.

Key Words: aVR, Coronary angiography, Infarct Related Artery, Inferior STEMI.

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Introduction

Various ECG criteria have been suggested to predict the culprit artery based on analysis of ST-segment elevation and depression in different leads[1-3]. More recently, ST-segment depression in lead aVR has been suggested as a predictor of Left Circumflex Artery (LCX) involvement[4-6]. aVR depression was also shown to be associated with significantly impaired myocardial perfusion[(7)]. Predicting the culprit artery in inferior STEMI can be challenging as the dominance of the Right Coronary Artery (RCA) and LCX can vary significantly among patients.

Stenosis of the proximal portion of RCA and RV involvement may cause RV failure and poor prognosis[8]. Considerable numbers of patients with highly suspected MI have normal on admission ECG, hence serial ECGs and also additional (right and posterior leads) may help physicians to deal with such cases[9].

Here we focused on different ECG pre-specified criteria for prediction of occluded vessel in acute inferior wall STEMI and role of lead aVR in identifying of Infarct Related Artery.

Methods

The study included 56 patients who were admitted to Manmohan Cardio Vascular Thoracic Centre (MCVTC), with diagnosis of acute inferior wall ST elevation myocardial infarction

Patients who met the following criteria were included in the study:

1. Anginal chest pain lasting for more than 30 minutes
2. ST elevation more than 1mm in leads II ,III, aVF
3. Who underwent coronary angiography during hospitalization, where the infarct related artery was confirmed.

Patients with the following conditions were excluded from the study

1. with previous history of acute myocardial infarction, CABG, PCI prior to the current hospitalization
2. Significant stenosis in both RCA and LCX so that the single infarct related artery could not be defined

A total of 56 patients who met the inclusion criteria were enrolled in the study. Forty patients underwent primary PCI and one patient received thrombolytic therapy in other centre. Admission ECG was recorded and analyzed. Left ventricular ejection fraction was estimated with transthoracic echocardiogram using Simpson's method. Coronary angiography was done for all patients during primary and elective Percutaneous Coronary Intervention (PCI). As per ADA criteria for the diagnosis of Diabetes Mellitus (DM), JNC[8] for Hypertension (HTN), 2013 ACC/AHA guideline for Dyslipidimea and World Health Organization (WHO) definition for smoking were used.

ECG analysis:

Standard 12 lead electrocardiograms were recorded at a speed of 25mm/s and voltage of 10mm/mV.The TP segment was used as the isoelectric line. The following findings were identified.

1. ST elevation in lead II and III
2. ST elevation in lead I, aVL, V5.V6
3. ST elevation in lead V1 and V4R
4. ST depression in lead I,aVL, V1,V2, V3
5. ST depression in lead aVR
6. Sum of ST depression of V1 to V3 divided by ST elevation of II, III, aVF

Coronary Angiography(CAG):

CAG was performed in all patients. The Infarct related artery was identified by either Total occlusion or a significant stenosis (>70%) of the RCA or LCX or their major branches. Criteria for single vessel and others, is defined with more than 50% lesion in major epicardial artery

All patients were followed up during their hospital stay. The presence of a second, third degree atrioventricular block, sustained ventricular tachycardia, ventricular fibrillation was noted. Death and cardiogenic shock were recorded.

The heart failure was diagnosed based on the presence of pulmonary rales, pulmonary edema, X ray chest or third heart sound.

Statistical Analysis:

All statistical analysis was performed using SPSS. Categorical data were analyzed in terms of frequency and continuous data presented as means ± SD.

Dichotomous variables were compared by Chi- square test and independent samples t test used to compare means of continuous variables. The sensitivity and specificity of ECG findings to predict the culprit artery were calculated.

Results

The mean age of the patients was 59.11± 11 years with 73% male . The youngest patient was a 36 year-old man and the oldest was a 84 year-old women. Among male patients 31.7% were diabetics and among female patients 26.6% were diabetics. (P value:0.716) 14 patients (25%) had a single vessel disease, 19 patients (34%) double vessel disease and 23 patients(41%) had a triple vessel disease: 50% of the patients with diabetes had Triple vessel disease.

Table 1: Baseline clinical Characteristics

Variables		No: 56
Male		Age: 57.59 ±10.96
Female		Age: 63.35± 10.34
DM		17(30.3%)
HTN		24(42.8%)
Smoking		36(64.2%)
Dyslipidemia		6 (10.7%)
Family history		3(5.3%)
Killip Class	I	37 (66%)
	II	12 (21.4%)
	III	3 (5.3%)
	IV	4 (7.1%)
CPK-MB		70.09±82.07
Troponin I		7.5± 17.32
Primary PCI		40 (71.4%)
Thrombolysis		1(1.7%)
LV EF:	Normal	30(53.5%)
	Mild LVSD	21(37.5%)
	Moderate LVSD	5(8.9 %)

The culprit artery was found to be the RCA in 40 patients (71.4%) and the LCX in 13 patients (23.2%). In remaining three patients the culprit arteries were Ramus intermedius 2 patient & LAD 1 patient. The baseline clinical characteristics are shown in Table1 and the angiographic data of all patients are displayed in Table2. The 25 patients (44.6%) with inferior wall myocardial infarction had right ventricular infarct and 6 patients (10.7%) had posterior wall involvement. In the RCA group 14 Patients(35%) had ST elevation in lead V1 and 1 Patient (7.7%) in the LCX group.

Table 2: IRA(Infarct –related artery) based on angiography

Culprit artery	Distribution (% of the total sample size)
RCA (Right coronary artery)	40 (71.4%)
Proximal	19(33.9%)
Middle	11(19.6%)
Distal	10(17.8%)
LCX (Left circumflex artery)	13(23.2%)
Proximal	6 (10.7%)
Non proximal	4 (7.1%)
Obtuse marginal	3(5.3%)
LAD (Left anterior descending artery)	1(1.7%)
RI (Ramus Intermedius)	2(3.5%)

ST depression in lead aVR was found in 10 patients (77%) with LCX related infarction and in 5patients (12%) with RCA related infarction(P-value: <0.001) 24 patients(60%) in the RCA group had ST elevation in lead V4R and 1patient (7.7%) in the LCX group.

RCA as the culprit artery:

The value of the ECG criteria and lead aVR in diagnosing RCA or LCX as the culprit artery is listed in table 3 and 4. With RCA related infarct, a greater ST elevation in lead III than in lead II (Figure 1) had sensitivity of 92% and specificity of 80%. A high sensitivity 92% and low specificity 45% were identified when Sum of ST depressions of V1to V3 divided by sum of ST elevation of inferior leads is ≤1. ST elevation in lead V4R had sensitivity of 81% and specificity of 45% for proximal RCA lesion.

Table 3: Value of ECG criteria in identifying the infarct related artery as RCA

ST segment deviation	Sensitivity	Specificity
RCA:		
Elevation in lead III>II	92%	80%
Elevation in lead V4R	81.25%	45%
Depression aVL > I	70.25%	53.3%
Sum of depressions of V1 to V3 Divided by sum of elevations of inferior leads ≤ 1	92.1%	45%

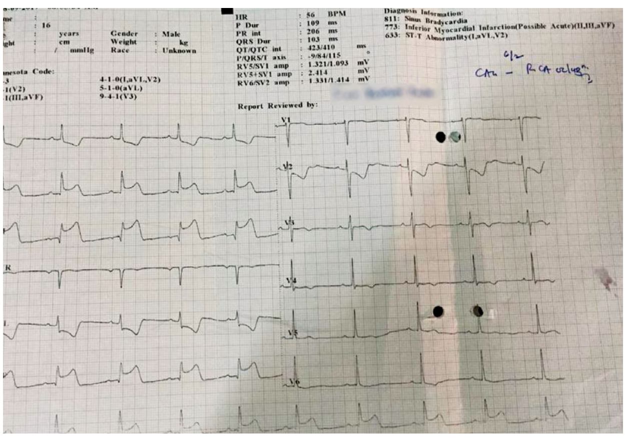

Figure 1: *ST elevation III>II*

LCX as the culprit artery:

With LCX related infarct , a greater ST elevation in lead II than in lead III (Figure 2) had a sensitivity of 83% and specificity of 90%. ST depression in lead aVR was associated with 83% sensitivity and 87.5% specificity in diagnosing LCX. The ST elevation in lead I was associated with high specificity 97% in diagnosing LCX involvement.

Table 4: Value of ECG criteria in identifying the infarct related artery as LCX

ST segment deviation	Sensitivity	Specificity
LCX:		
Elevation in lead II > III	83%	90%
Elevation in lead V5, V6	40%	86%
Depression in lead aVR	83.3%	87.5%
Sum of depressions of V1to V3 Divided by sum of elevations Of inferior leads >1	42%	92%

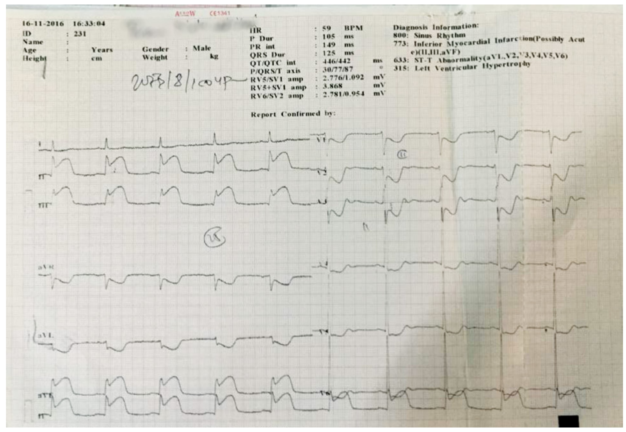

Figure 2 : *ST elevation II>III*

In-Hospital outcome

During hospitalization 4 patients (7.1%) were in cardiogenic shock and 10 patients (17.8%) had second or third degree AV block. The in-hospitality mortality was in 2 patients (3.5%). One patient died due to cardiogenic shock and another patient due to refractory ventricular arrhythmia. The in hospital outcomes of the patients is shown in table 5.

Table 5: In Hospital outcomes

Variables	Distribution
Cardiogenic shock	4(7.1%)
2nd , 3rd AV Block :	10(17.8%)
VT/VF	6 (10.7%)
Sinus Bradycardia requiring TPI	3 (5.3%)
AF	2 (3.5%)
Post MI pericarditis:	2 (3.5%)
Post MI pericardial effusion:	1(1.7%)
CPR	4(7.1%)
Death	2(3.5%)

In order to assess the prognostic value of ST-segment deviation in lead aVR,(Shown in table 6) patients were re-divided according to the presence or absence of ST-segment deviation (elevation or depression) in lead aVR. Arrhythmic events, namely AV-block or VF/VT, were comparable in both groups.

Table 6: Prognostic value of ST segment deviation in lead aVR

Complications	ST-segment Deviated in aVR (20 patients)	ST-segments isoelectric in aVR (36 patients)	P-value
In hospital mortality	1(5%)	1(2.7%)	1.00
AV block	3(15%)	7(19.4%)	1.00
VT/VF	3(15%)	3(8.3%)	0.65
AF	2(10%)	0(0%)	0.12

Discussion

In STEMI the time of blood flow reestablishment in infarct area is crucial. Immediate and accurate stratification of high-risk patients is also important in this situation. Identifying the culprit artery on presenting ECG can lead to earlier risk stratification and better guidance of therapy for reperfusion. The culprit artery of anterior STEMI is nearly always the left anterior descending artery, but inferior STEMI can be caused by an occlusion of either the right coronary artery (RCA) or left circumflex artery (LCX).

The RCA supplies blood mainly to the inferior myocardium, whereas the LCX supplies blood to the posterior, posterolateral, or posteroinferior myocardium[10]. This study found that in patients with inferior STEMI, the RCA is much more likely than the LCX to be the culprit artery, with a ratio of 3:1. These results are consistent with previous other studies by where the RCA to LCX ratio was found to vary from 2.2:1 to 7.0:1 [11-15]

The diagnostic value of the different ECG criteria was assessed in this study as mentioned in (Table 2 and 3). In most patients with RCA occlusion the current of injury will be reflected more in lead III than in lead II. Conversely, with LCX occlusion the current of injury will be seen more in lead II than in lead III [11]. Walid Elhammady found that ST elevation in lead III > II for RCA lesion had sensitivity and specificity of 92% and 78% respectively and for LCX lesion, lead II >III with sensitivity and specificity of 80% and 93% respectively[16]. The reported sensitivity and specificity of Fiol et al[17] study, for RCA prediction, were 96% and 38% respectively. Various ECG findings have been evaluated to differentiate the culprit artery in acute inferior wall STEMI. Still, there is a small portion of patients whose culprit artery can not be accurately identified by these criteria. In our study 2 patients had involvement of Ramus Intermedius as the culprit artery and 1 patient with LAD as the culprit artery.

The important finding of our study is that aVR depression represents myocardial infarction involving the LCX artery with good sensitivity and specificity. In our study ST depression in lead aVR was in 77% of the LCX group with sensitivity and specificify of 83.3% and 87.5% respectively.

Sun et al.[18] found that ST depression in aVR was found in 70% of patients who had LCX as the infarct related artery with sensitivity and specificity of 70.0% and 94.3%, respectively. Walid Elhammady found that ST depression in aVR was found in 85% who had LCX as the culprit artery with sensitivity and specificity of 86% and 92% respectively[16]. In RCA occlusion, the injury vector is toward the right side and results in ST depression in leads I and aVL.[19]. To define the proximal occlusion of RCA, Fiol et al[20] proposed aVL depression ≥ lead I depression as a criterion. In our study ST depression in lead aVL > I for proximal RCA occlusion had sensitivity and specificity of 70% and 53% .

The ST segment elevation in V4R (occluded before right ventricular branch) is useful for identifying occlusion of RCA. Occlusion of proximal-RCA in right dominant hearts, led to ST elevation of right precordial leads due to RV involvement[21]. In our study the sensitivity and specificity of ST elevation in V4R for proximal RCA was 81% and 45% respectively.

The in-hospital mortality in our study was 3.6%. In the study conducted by Walid Elhammady, the in hospital mortality was 5%[16]. In the study conducted by Malla RR et al the in-hospital mortality in patients with inferior wall myocardial infarction was 5.6%[22] In the present study it was observed that higher rates of death (6.6% vs. 2.4%,) and arrhythmia in patients with ST segment deviation compared to patients with no ST segment changes. Similar results were observed in the study conducted by Walid Elhammady[16]. These findings were supported by Kukla et al.[23] findings, who stated that ST segment changes in lead aVR occurred in approximately half of inferior wall STEMI patients. The presence of such ST segment changes was associated with a poorer prognosis during the hospital stay. From the present study it was shown that patients with ST segment deviation in aVR were at a higher risk.

Limitation of the study:

This study has a small sample size and was a single center study.

Conclusion:

The present study showed that lead aVR which is neglected is useful in clinical practice when assessing patients with inferior STEMI as the presence of ST segment depression in aVR suggests a LCX infarction with good sensitivity and specificity. In addition, ST segment deviation in aVR was associated with poor in-hospital outcome.

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