Prediction of an Infarct Related Artery on Electrocardiogram and its Correlation with Coronary Angiography in an Acute Myocardial Infarction

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Abstract

Aim: To Predict an infarct related artery on Electrocardiogram and its correlation with Coronary angiography in an Acute myocardial Infarction. **Materials and Methods:** The study was carried out as a prospective observational study of 70 patients at medical college & tertiary health care Centre, over a period of two years that included cases of patients diagnosed to have acute myocardial infarction on ECG for the first time & have also undergone coronary angiography. **Results:** Study showed most common age group amongst study population was 51 to 60 yrs (42.9%) followed by 61 to 70 yrs (37.1%). LAD (71%) was the most common coronary artery amongst study population followed by RCA (25%) and LCX (4%). Most of the study population had ECG findings like ST depression III + aVF ≥ 2.5 (36%) and ST segment in III and aVF isoelectric or elevated (36%) followed by ST depression in III + aVF ≤ 2.5 and ≥ 0.5 (28%) in LAD occlusion. In the present study, most of the study population had ECG findings like ST↑LIII > ST↑ LII > 1 (94.12%), ST↓LI, aVL (82.35%) and ST↑V4R > 1 mm (70.59%) in RCA occlusion. In the present study, most of the study population had ECG findings like ST ↑ LII > LIII (100%) and Isoelectric or ST ↑ I,aVL (66.7%) in LCX occlusion. **Conclusion:** ECG criteria have excellent sensitivity and specificity in predicting the culprit artery Anterior ST elevation identified all patients with LAD as the culprit artery with 100 % accuracy in our study population. In patients with inferior ST elevation, relative ratio of ST elevation in lead II and lead III, correctly identified the culprit artery as RCA or LCx with 100 % accuracy. (ST elevation in lead II > III predicts LCx occlusion and the reverse predicts RCA occlusion.

Keywords: Acute Myocardial Infarction, Coronary Angiography, Electrocardiography

1. Introduction

Cardiovascular diseases (CVDs) have become the leading cause of mortality in India[1]. In comparison with the people of European ancestry, CVD affects Indians at least a decade earlier and in their most productive midlife years[2,3]. In India, this number is 52%[4]. The World Health Organization (WHO) has estimated that, with the current burden of CVD, India would lose $237 billion from the loss of productivity and spending on health care over a 10-year period (2005–2015)[5].

The blood supply to the heart is established by three arteries: Left Anterior Descending (LAD), Right Coronary (RCA), and Circumflex (CX)[3]. Acute Myocardial Infarction (AMI) usually occurs when the coronary flow suddenly decreases after an obstruction or thrombotic occlusion in a coronary artery previously affected by atherosclerosis. There are very few studies evaluating correlation of anterior and inferior wall MI with respect to ECG changes and corresponding angiographic evidences.

A detailed analysis of patterns of ST-segment elevation may influence decisions regarding the perfusion therapy.

The early and accurate identification of the infarct related artery can help predict the area of myocardium at risk and guide decisions regarding the urgency of revascularization. Electrocardiographic signs of reperfusion represent an important marker of micro vascular blood flow and consequent prognosis. Electrocardiography reflects the electrophysiology of myocardium during acute ischemia and coronary angiography identifies the vessel anatomy. Thus the coronary angiography remains the "gold standard" for identifying infarct related artery, and the ECG remains the "gold standard" for identifying the presence and location of acute myocardial ischemia[6].

Acute transmural ischemia caused by occlusion of a coronary artery is usually represented by an elevation in the ST segment[7]. The Electrocardiogram (ECG) is undoubtedly the most accessible and useful tool for initial assessment, screening, and risk stratification in patients with a suspected acute coronary event, as well as an "indicator" of the therapy to be instituted in these patients[7,8].

In recent years, frequent studies have appeared in the medical literature that aims to determine which electrocardiographic features allow identification of the artery responsible for the AMI and the location of the arterial lesion. The study by Y Birnbaum *et al.* and by C.S. The Janandan Reddy *et al.* has showed criteria regarding ST-T changes with related vessels[9].

According to some studies, an accurate ECG analysis can determine if the AMI occurred due to occlusion of the LAD with sensitivity of 90.0% and specificity of 95.0%, and whether it occurred due to an occlusion in the RC or CX with sensitivity of 53.0% and specificity of 98%[7]. Rapid recognition of STEMI by the ECG is crucial for the indication of percutaneous coronary intervention with direct angioplasty. Although the blood flow can be reestablished in more than 85% of the cases, the prognosis depends on the capacity of the existing microcirculation in the affected tissue[10].

2. Materials and Methods

This was prospective observational study carried out in tertiary care teaching hospital with 70 patients included over period of two years. Patients diagnosed to have acute myocardial infarction on ECG for the first time, ECG were analysed based on ST elevation changes in different leads, patients were thrombolysed and looked for complications

and managed in ICCU, also informed consent was taken from relatives to undergo angiography and angioplasty, and these were included in the study. Patients with a Previous diagnosis of myocardial infarction, Valvular disease, Myocardial disease, Paced ventricular rhythm, Left bundle branch block, Patients who had undergone revascularization in the past and Pericarditis were excluded. These ST elevations on ECG were tabulated and compared with angiography findings. After data collection, it was analyzed using Microsoft excel 2007.

3. Results

In the present study, 51 to 60 yrs. (42.9%) were the most common age group amongst study population, there was male predominance amongst study population (71%). Hypertension (61.4%) was the most common major comorbidity amongst study population followed by Diabetes (51.4%), Smoking (37.1%) and Alcohol (31.4%).
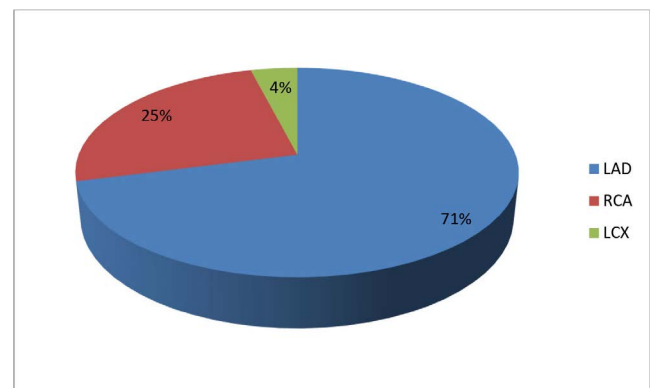

Figure 1. Distribution of culprit Artery on angiography in study population.

As[7] seen in the above pie chart, LAD (71%) was the most common coronary artery amongst study population followed by RCA (25%) and LCX (4%) (Figure 1).

In our study, in relation of occlusion to S1 (LAD), most of the study population had Occlusion proximal to S1 (68%), also in relation of occlusion to D1 (LAD), most of the study population had Occlusion proximal to both D1 (64%).

Most of the study population had ECG findings like ST depression III + aVF ≥ 2.5 (36%). In our study group of 50 patients having LAD as culprit artery, of the 18 patients (36%) who had ST depression in III + aVF ≥ 2.5, 12 patients had proximal lesion to D1.

In our study sum of ST depression III + aVF ≥ 2.5 was found to have low sensitivity (37.50%) but high specificity (66.67 %) for lesion proximal to S1 (Table 1).

Thus marked ST depression in III, aVF (Sum of ST depression in III and AVF ≥ 2.5 mm) was found to have high specificity (96.67 %) for a occlusion proximal to D1 but with a low sensitivity of 37.50 %.

On the other hand, an elevated or isoelectric ST segment in III, aVF has low sensitivity (34.38%) and moderate specificity (61.11%) for an occlusion distal to D1.

In our study group of 50 patients having LAD as culprit artery, of the 34 patients (68%) who had Sum of aVR + V1 –V6 ≥ 0, 24 patients had proximal lesion with regard to S1.

Of the 16 patients (30 %) who had Sum of aVR + V1 – V6 < 0, 10 patients had proximal lesion and 6 patients had distal lesion with regard to S1 (Table 2).

Thus, marked sum of ST deviation (aVR + V1 – V6 ≥ 0) was found to have low specificity (37.50%) for an occlusion proximal to S1 but with a moderate sensitivity of 70.59%.

On the other hand, a sum of ST deviation (aVR + V1 – V6 < 0) has low sensitivity (29.41%) and moderate specificity (62.50%) for an occlusion distal to S1.

As seen in the above table, out of 20 patients with IWMI, 17 patients had culprit lesion localized RCA and Left circumflex artery in 3 patients by CAG (Table 3).

As seen in the above table, most of the study population had ECG findings like ST↑LIII > ST↑LII > 1 (94.12%),

Table 1. Sensitivity, specificity, PPV, NPV of different ECG criteria Described in relation to d1

	Sensitivity	Specificity	PPV	NPV
Ability of ST depression in III + aVF ≥ 2.5 to predict lesion proximal to D1	37.50%	96.67%	66.67%	37.50%
Ability of ST elevated or isoelectric in III + aVF to predict lesion Distal to D1	34.38%	61.11%	61.11%	34.38%

Table 2. Sensitivity, specificity, PPV, NPV of different ECG criteria described in relation to S1

	Sensitivity	Specificity	PPV	NPV
Ability of sum of ST deviation (aVR + V1 – V6 ≥ 0) to predict lesion proximal to S1	70.59%	37.50%	70.59%	37.50%
Ability of sum of ST deviation (aVR + V1 – V6 < 0) to predict lesion distal to S1	29.41%	62.50%	62.50%	29.41%

Table 3. Inferior wall myocardial infarction amongst study population

Site of Occlusion	Number of patients	%
Proximal RCA	8	40
Distal RCA	9	45
LCX	3	15
Total	20	100

Table 4. ECG findings in RCA occlusion amongst study population

RCA occlusion	Frequency	Percent
ST↑LIII > ST↑ LII	16	94.12
ST↓LI, aVL	14	82.35
ST↑V4R > 1 mm	12	70.59

Table 5. ECG findings in LCX occlusion amongst study population

LCX occlusion	Frequency	Percent
ST ↑ LII > LIII	3	100
Isoelectric or ST ↑ I,aVL	2	66.7

ST↓LI, aVL (82.35%) and ST↑V4R > 1 mm (70.59%) in RCA occlusion (Table 4).

As seen in the above table, most of the study population had ECG findings like ST ↑ LII > LIII (100%) and Isoelectric or ST ↑ I,aVL (66.7%) in LCX occlusion (Table 5).

In our study, of 17 patients having RCA as culprit artery, 16 patients (94.12%) had ST↑LIII > ST↑LII, 14 patients had ST↓LI, aVL, and 12 patients had ST↑V4R > 1 mm. Of 3 patients having LCX as culprit artery, 1 patient (66.70%) had ST↑LIII > ST↑LII.

	Sensitivity	Specificity	PPV	NPV
ST↑LIII > ST↑LII	94.12%	66.67 %	94.12%	66.67 %
ST↓LI, aVL	82.35%	100%	82.35%	100%
ST↑V4R > 1 mm	70.59 %	100%	70.59%	100%

ST↑LIII > ST↑LII was found to have high sensitivity (94.12%) but moderate specificity (66.67 %).

On the other hand, ST↓LI, aVL was found to have high sensitivity (82.35%) but high specificity (100 %).

On the other hand, ST↑V4R > 1 mm was found to have moderate sensitivity (70.59 %) but high specificity (100 %).

In our study, of 3 patients having LCX as culprit artery, 3 patients (100%) had ST↑LII > LIII, 2 patients had Isoelectric or ST↑I, aVL (66.7%).

Of 17 patients having RCA as culprit artery, 2 patients had ST↑LII > LIII (11.7 %) had Isoelectric or ST↑I, aVL (17.64%).

ST ↑ LII > LIII was found to have high sensitivity (100 %) but moderate specificity (84 %)

On the other hand, Isoelectric or ST ↑ I, aVL was found to have moderate sensitivity (66.67%) but high specificity (82.35 %) (Table 7).

Table 7. Sensitivity, specificity, PPV, NPV of different ECG criteria for LCX

	Sensitivity	Specificity	PPV	NPV
ST ↑ LII > LIII	100%	84 %	100%	84 %
Isoelectric or ST ↑I, aVL	66.67%	82.35 %	66.67%	82.35 %

4. Discussion

In the present study, 51 to 60 yrs (42.9%) was the most common age group amongst study population. This finding is in agreement with the study conducted by Dattatraya Narayan Hambire et al.[12] The INTERHEART Study observed Southeast Asia and Japan[13], North America[14] that were almost same mean age (years) as in our study observed[15]. Age is the most powerful independent risk factor for atherosclerosis.

In the present study, there was male predominance amongst study population (71%). This finding is in agreement with the study conducted by Alappatt, et al.[16] in which 74% male and 26% females are noticed with ACS. Huma et al. in 2012,[17] found that at any given age men are more at risk than women, particularly before menopause, at least part of the apparent protection against coronary artery disease in premenopausal women derives from their relatively higher HDL levels compared with those of men. Deborah et al.,[18] in her study in 2006 also found that AMI was more likely in men than women.

In the present study, hypertension (61.4%) was the most common major comorbidity amongst study population followed by Diabetes (51.4%), Smoking (37.1%) and Alcohol (31.4%). This shows females are at a high risk of getting hypertension which is a major risk factor of ACS. Wander et al. observed hypertension in 47% of the patients[19].

In the present study, LAD (71%) was the most common coronary artery amongst study population, out of which most of the study population had Occlusion proximal to both S1 and D1 (52%). In the present study, in relation of occlusion to S1 (LAD), most of the study population had Occlusion proximal to S1(68%).

In the present study, most of the study population had ECG findings like ST depression III + aVF ≥ 2.5 (36%) and ST segment in III and aVF isoelectric or elevated (36%) followed by ST depression in III + aVF ≤ 2.5 and ≥ 0.5 (28%) in LAD occlusion.

In our study group of 50 patients having LAD as culprit artery, of the 18 patients (36%) who had ST depression in III + aVF ≥ 2.5, 12 patients had proximal lesion and 6 patients had distal lesion with regard to D1.

Martínez-Dolz L, et al.[20] reported that ST in leads II, III, or aVF measured both at the level of the J point and at 80 ms from the J point that was greater than 0.5 to 1 mm was a predictor of damage proximal to the septal and diagonal arteries (S+D), with a sensitivity of 79% and specificity of 71% (P=.002) when the cut-off point was a depression of more than 1 mm in the J point. ↓ ST in leads II, III, or aVF was also associated in a significant manner with damage proximal to the dominant diagonal

artery (D), with an acceptable sensitivity of 60% and an acceptable specificity of 75% (for an ST depression of more than 1 mm in the J point).

In our study sum of ST depression III + aVF ≥ 2.5 was found to have low sensitivity (37.50%) but high specificity (66.67 %) for lesion proximal to S1.

Thus, the magnitude of the ST depression in the inferior face was correlated with the site of the LAD occlusion[21,22-24], with the degree of ST elevation in the precordial leads (reciprocal effect), and with the seriousness of the ischemia of the anterior wall and was associated with a larger area of infarction, increased morbidity, and a worse prognosis[25-27].

Thus, marked ST depression in III, aVF (Sum of ST depression in III and AVF ≥ 2.5 mm) was found to have high specificity (96.67 %) for an occlusion proximal to D1 but with a low sensitivity of 37.50%. This finding is in agreement with the study conducted by Koju R et al.,[28] it was observed that sensitivity of ST depression in inferior leads to predict the proximal LAD lesion were 85%, 88% and 85% respectively, whereas specificity were 78%, 67% and 78% respectively. ST segment elevation in aVR had 42% sensitivity and 97% specificity to predict proximal lesion.

On the other hand, an elevated or isoelectric ST segment in III, aVF has low sensitivity (34.38%) and moderate specificity (61.11%) for an occlusion distal to D1. This finding is in agreement with the study conducted by Koju R et al.[28].

In our study group of 50 patients having LAD as culprit artery, of the 34 patients (68%) who had Sum of aVR + V1 −V6 ≥ 0, 24 patients had proximal lesion and 10 patients had distal lesion with regard to S1.

Of the 16 patients (30%) who had Sum of aVR + V1 − V6 < 0, 10 patients had proximal lesion and 6 patients had distal lesion with regard to S1. Thus, marked sum of ST deviation (aVR + V1 − V6 ≥ 0) was found to have low specificity (37.50%) for an occlusion proximal to S1 but with a moderate sensitivity of 70.59%.

In the present study, out of 20 patients with IWMI, 8 patients had culprit lesion localized to proximal RCA, 9 in distal RCA and Left circumflex artery in 3 patients by CAG.

In the present study, most of the study population had ECG findings like ST↑LIII > ST↑ LII > 1 (94.12%), ST↓LI, aVL (82.35%) and ST↑V4R > 1 mm (70.59%) in RCA occlusion and most of the study population had ECG findings like ST ↑ LII > LIII (100%) and Isoelectric or ST ↑I, aVL (66.7%) in LCX occlusion.

In our study, of 17 patients having RCA as culprit artery, 16 patients (94.12 %) had ST↑LIII > ST↑ LII, 14 patients had ST↓L I, aVL, and 12 patients had ST↑V4R > 1 mm. This result is consistent with research done by Radhakrishnan Nair et al.,[11] shows a sensitivity of 96%, a specificity of 40%, a positive predictive value of 89% and a negative predictive value of 67% for RCA involvement.

These results suggest that a ratio of ST elevation in lead III/ ST elevation in lead II > 1 is an important predictor of RCA occlusion, a finding consistent with that of previous studies as Zimetbaum et al.,[29] who had showed that a higher ST segment elevation in lead III than in lead II was only seen in RCA occlusion, and Chia et al.[30] Huey et al.[31] demonstrated ST depression in lead I in 22% of their LCX patients and 59% of their RCA patients, whereas Kontos et al.[32] reported this finding in 28% of their LCX patients and 58% of their RCA patients.

Of 3 patients having LCX as culprit artery, 1 patient (66.70%) had ST↑LIII > ST↑ LII. ST↑LIII > ST↑LII was found to have high sensitivity (94.12%) but moderate specificity (66.67 %). On the other hand ST↓LI, aVL was found to have high sensitivity (82.35%) but high specificity (100 %) and ST↑V4R > 1 mm was found to have moderate sensitivity (70.59%) but high specificity (100 %) These findings were also consistent with Glancy et al.[11].

In our study, of 3 patients having LCX as culprit artery, 3 patients (100%) had ST ↑ LII > LIII, 2 patients had Isoelectric or ST ↑I, aVL (66.7%).

5. Summary

The most common age group amongst study population was 51 to 60 yrs (42.9%). There was male predominance amongst study population (71%).Hypertension (61.4%) was the most common past history amongst study population followed by Diabetes (51.4%), Smoking (37.1%) and Alcohol (31.4%).

LAD (71%) was the most common coronary artery amongst study population followed by RCA (25%) and LCX (4%). Most of the study population had Occlusion proximal to both S1 and D1 (52%) followed by Occlusion distal to both S1 and D1 (20%). In relation of occlusion to S1 (LAD), most of the study population had Occlusion proximal to both S1 (68%).In relation of occlusion to

D1 (LAD), most of the study population had Occlusion proximal to both D1 (64%).

Most of the study population had ECG findings like ST depression III + aVF ≥ 2.5 (36%) and ST segment in III and aVF isoelectric or elevated (36%) in LAD occlusion. Sum of ST depression III + aVF ≥ 2.5 was found to have high specificity (66.67 %) for lesion proximal to S1. Thus, marked ST depression in III, aVF (Sum of ST depression in III and AVF ≥ 2.5 mm) was found to have high specificity (96.67%) for an occlusion proximal to D1 but with a low sensitivity of 37.50 %. Marked sum of ST deviation (aVR + V1 – V6 ≥ 0) was found to have low specificity (37.50%) for an occlusion proximal to S1 but with a moderate sensitivity of 70.59%.

In the present study, Out of 20 patients with IWMI, 8 patients had culprit lesion localised to proximal RCA, 9 in distal RCA and Left circumflex artery in 3 patients by CAG out of which most of the study population had ECG findings like ST↑LIII > ST↑ LII > 1 (94.12%), ST↓LI, aVL (82.35%) and ST↑V4R > 1 mm (70.59%) in RCA occlusion and had ECG findings like ST ↑ LII > LIII (100%) and Isoelectric or ST ↑ I,aVL (66.7%) in LCX occlusion.

In our study, of 17 patients having RCA as culprit artery, ST↑LIII > ST↑ LII was found to have high sensitivity (94.12 %) but moderate specificity (66.67 %). ST↓LI, aVL was found to have high sensitivity (82.35%) but high specificity (100 %). On the other hand ST↑V4R > 1 mm was found to have moderate sensitivity (70.59 %) but high specificity (100 %). ST ↑ LII > LIII was found to have high sensitivity (100 %) but moderate specificity (84 %). On the other hand, Isoelectric or ST ↑ I, aVL was found to have moderate sensitivity (66.67%) but high specificity (82.35 %)

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