Original Research Article

Role of electrocardiogram in identifying the infarct related artery in acute myocardial infarction and to correlate it with 2D echo and coronary angiogram

Jacob Abraham Ruram, Rami Reddy Ganta, P. Arunachalam*

Department of Cardiology, Meenakshi Medical College Hospital and Research Institute, Meenakshi Academy of Higher Education and Research, Kanchipuram, Tamil Nadu, India

*Correspondence:
Dr. P. Arunachalam,
E-mail: p.arunachalam@gmail.com

Copyright: © the author(s), publisher and licensee Medip Academy. This is an open-access article distributed under the terms of the Creative Commons Attribution Non-Commercial License, which permits unrestricted non-commercial use, distribution, and reproduction in any medium, provided the original work is properly cited.

ABSTRACT

Background: The Electrocardiogram remains a crucial tool in the identification and management of acute myocardial infarction. A detailed analysis of patterns of ST segment elevation may influence decisions regarding the perfusion therapy. This study was undertaken to study the role of ECG in identifying the infarct related artery in acute ST elevation MI and to correlate its findings with 2 D ECHO and Coronary angiogram.

Methods: A total of 100 patients who presented with acute ST elevation MI were randomly selected for the study. After admission all the patients underwent ECG, CPK, CK-MB levels, 2D ECHO and CAG. Patients with ST segment elevation from ECG was evaluated to identify culprit vessel and the ECG findings were then correlated with 2D ECHO and CAG to identify the Sensitivity, Specificity, Positive predictive value and Negative predictive value of ECG in identifying the infarct related artery.

Results: Fifty-two (52%) patients had an Anterior wall MI, forty-two patients (42%) had an evidence of Inferior wall MI and Six patients (6%) were found to have Antero inferior wall MI in the study group. Thirty-eight (38%) had evidence of SVD, forty-six patients (46%) had DVD and Sixteen patients (16%) had TVD. Sensitivity, Specificity, PPV and NPV of the ECG in identifying the LAD artery occlusion were 60.5%, 100%, 100% and 44.4% respectively. Sensitivity, Specificity, PPV and NPV of ECG in identifying the RCA artery occlusion were 78.5%, 100%, 100% and 78.5% respectively. Sensitivity, Specificity, PPV and NPV of the ECG in identifying the LCx artery occlusion were 26%, 96%, 86% and 60% respectively.

Conclusions: ECG was found to be a sensitive and specific tool in identifying the infarct related Coronary artery in acute ST elevation MI.

Keywords: Creatinine kinase, Electrocardiogram, Echocardiogram, Myocardial infarction

INTRODUCTION

It is widely acknowledged that heart disease and stroke are the leading causes of death and disability worldwide in developed as well as in developing countries. While the mortality associated with cardiovascular disease seems to be declining in Western Europe and North America, the burden of cardiovascular diseases in developing countries continues to rise and is expected to be a major cause of death in adults from low-income and middle-income countries worldwide.[1]

The incidence and prevalence of Coronary artery disease (CAD) has increased tremendously in India during the

last two decades and this change is largely attributable to lifestyle changes.[2] India has reportedly shown the highest burden of Acute coronary syndromes in the world.[3]

The electrocardiogram remains a crucial tool in the identification and management of acute myocardial infarction. Acute risk stratification in myocardial infarction is still based on simple clinical parameters, laboratory markers and 12 lead electrocardiography. The electrocardiogram has been a preliminary screening and one of the most useful diagnostic investigations in myocardial infarction. Patients are diagnosed as having anterior, inferior or lateral myocardial infarction based on patterns and magnitude of ST deviation.

The early and accurate identification of the infarct-related artery on the Electrocardiogram can help predict the amount of myocardium at risk and guide decisions regarding the urgency of revascularization. Electrocardiographic signs of reperfusion represent an important marker of microvascular blood flow and consequent prognosis.

The electrocardiogram is also crucial for identifying new conduction abnormalities and arrhythmias that influence both short- and long-term outcome.[4] Patients in India who have acute coronary syndromes have a higher rate of STEMI than do patients in developed countries. Since most of these patients are poor, they are less likely to get evidence-based treatments and had greater 30-day mortality. Reduction of delays in access to hospital and provision of affordable treatments could reduce morbidity and mortality.[3] Thrombolytic therapy for patients with AMI improves the infarct coronary artery patency, limits AMI size, improves left ventricular function and survival, as demonstrated in large placebo-controlled clinical trials. With the advent of interventions aimed at limiting AMI size, it becomes important to assess the amount of ischemic myocardium in the early phase of AMI, and to develop noninvasive methods for evaluation of these therapies.[5] Hence, the present study was done to evaluate the sensitivity and specificity of ECG in early identification of the coronary artery involved in acute ST elevation MI in comparison to 2D Echo and Coronary angiogram.

METHODS

A total of 100 cases of Acute MI diagnosed by ECG and Cardiac enzymes in patients aged more than 18 years admitted in Meenakshi Medical College Hospital and Research Institute, Kanchipuram between September 2018 and August 2019 were included in the study. All of these patients were randomly selected.

Inclusion criteria

- All patients were selected on the basis of:
- Chest pain or discomfort lasting more than 30 minutes

- ECG showing ST elevation of 1mm or more in limb leads and 2mm or more in pericardial leads in two contagious leads.
- Elevation of cardiac enzymes (CPK and CPKMB)

Exclusion criteria

Patients with history of Previous myocardial infarction, Prior CABG, Congenital heart disease, Left BBB in baseline ECG, Clinical and ECG features suggestive of Pericarditis, ECG features suggestive of Early repolarisation syndrome ,Patients who do not agree to undergo ECHO or coronary angiogram, Refusal to give consent.

Clinical protocol

Brief history was elicited in each case following admission with reference to the time of onset and duration of symptoms like chest pain/and or dyspnoea, and the presence of risk factors like diabetes, hypertension, smoking and alcohol. A 12 lead ECG was done at admission and CPK and CKMB levels was done in all patients within half an hour of admission to the hospital. Further patients also underwent 2D echo within 24 hrs of presentation to the hospital for the evaluation of regional wall motion abnormalities and to know the LV function. Then these patients were subjected to CAG (coronary angiogram) after their informed consent was taken. All the above data were collected and recorded in a standard proforma.

RESULTS

Gender wise distribution of patients

Table 1 showed that the gender wise distribution of patients. Number of patients included in the study: 100. Men formed 86% of the study group while women formed 14% of the study group.

Table 1: Gender distribution of patients.

Gender	Number	%
Male	86	86
Female	14	14

Table 2: Age wise distribution according to gender.

Age in years	Male (n=86)	Female (n=14)	Total
31-40	16(19%)	0	16
41-50	22(26%)	6(43%)	28
51-60	28(33%)	4 (28.5%)	32
61-70	8(9%)	4(28.5%)	12
71-80	12(14%)	0	12
Total	86 (100%)	14(100%)	100

Chi-square=4.813 p=0.307 NS

Age wise distribution of patients

Table 2 indicates that the age wise distribution of patients. The age between 51-60years of MI patients were significantly increased when compared with other age groups of 31-40, 41-50, 61-70 and 71-80 years.

Risk factors

In the present study Table 3 indicates that the coronary risk factors of MI patients. In the study 62% were found to have type 2 diabetes mellitus and 76% were found to have systemic hypertension, 76% of the patients were smokers and 56% of the patients consumed alcohol on regular basis.

Table 3: Coronary risk factors of patients studied.

Risk factor	Number (n=100)	Percent%
Hypertensive	76	76
Smoking	76	76
Diabetics	62	62
Alcohol	56	56

Electrocardiographic diagnosis

In the study inferior wall MI formed 42% of the study population and anterior wall MI including anterolateral and anteroseptal formed 52% of the study group while the anteroinferior wall MI formed 6% of the study population (Table 4).

Table 4: Electrocardiographic diagnosis of MI patients.

Diagnosis	Number	%
Anteroseptal wall MI	22	22
Extensive anterior wall MI	16	16
Anterolateral wall MI	14	14
Inferior wall MI	42	42
A /IWMI	6	6
Total	100	100

Correlation of ECG changes with coronary angiogram

Sensitivity= 60.5% Specificity=100% Positive predictive value=100% Negative predictive value= 44.4%. There is significant difference in ECG findings of patients with CAG evidence of LAD and no evidence of LAD occlusion.

Number of patients who had ECG evidence of ST elevation in V1-V3 with ST↑ in lead V1>2.5mm are 46. Number of patients who have no ECG evidence of ST elevation in V1-V3 with ST↑ in lead V1>2.5mm are 54.

Number of patients who had ECG evidence of LAD artery are 76. Number of patients who had no evidence of LAD artery are 24 (Table 5).

Table 5: Correlation of ECG changes with CAG in LAD artery occlusion.

			LAD (CAG)		
			+	-	Total
ECG	+	Count	46	0	46
		% within ECG	100.0%	0.0%	
		% within LAD artery	60.5%	0.0%	
	-	Count	30	24	54
		% within ECG	55.6%	44.4%	
		% within LAD artery	39.4%	100.0%	
Total		Count	76	24	100

p =0.002 sig

Sensitivity= 26% Specificity=96% Positive predictive value=86% Negative predictive value= 60%.

There is significant difference in ECG findings of patients with CAG evidence of LCx and no evidence of LCx occlusion. Number of patients who have ECG evidence of ST elevation in ST ↑ II>III with ST↑ I, aVL, V5, V6 and ST↓ V1-V3 are 14.

Number of patients who do not have ECG evidence of ST elevation in ST ↑ II>III with ST↑ in I, aVL, V5, V6 and ST↓ V1-V3 are 86. Number of patients who had CAG evidence of LCx artery are 46. Number of patients who had no evidence of LCx artery are 54 (Table 6).

Table 6: Correlation of ECG changes with CAG in LCx artery occlusion.

			LCx(CAG)		
			+	-	Total
ECG	+	Count	12	2	14
		% within ECG	85.7%	14%	
		% within LCx artery	26%	37%	
	-	Count	34	52	86
		% within ECG	39.5%	60.5%	
		% within LCx artery	62.5%	96.2%	
Total		Count	46	54	100

p =0.038sig.

Sensitivity= 78.5% Specificity=100% Positive predictive value=100% Negative predictive value= 78.5%.

There is significant difference in ECG findings of patients with CAG evidence of RCA and no evidence of RCA occlusion.

Number of patients who have ECG evidence of ST ↑ III>II with ST↓ I, aVL are 44. Number of patients who do not have ECG evidence of ST ↑ III>II with ST↓ I, aVL

are 56. Number of patients who had CAG evidence of RCA artery are 56. Number of patients who had no evidence of RCA artery are 44 (Table 7).

Table 7: Correlation of ECG changes with CAG in RCA artery occlusion.

			RCA(CAG)		
			+	-	Total
ECG	+	Count	44	0	44
		% within ECG	100%	0%	
		% within RCA artery	78.5%	0%	
	-	Count	12	44	56
		% within ECG	21.5%	78.5%	
		% within RCA artery	21.4%	100%	
Total		Count	56	44	100

p=<0.0005

Sensitivity=58%, Specificity=100%, Positive predictive value=100%, Negative predictive value=43%

There is significant difference in 2 D ECHO findings of patients with CAG evidence of LAD and no evidence of LAD occlusion.

Number of patients who had evidence of Ant/apex/antsep hypokinesia are 44. Number of patients who had no evidence of Ant/apex/antsep hypokinesia are 56. Number of patients who had evidence of LAD artery occlusion are 76. Number of patients who had no evidence of LAD artery occlusion are 24 (Table 8).

Table 8: Correlation of 2D ECHO changes with CAG in LAD artery occlusion.

			CAG(LAD)		
			+	-	Total
ECHO	+	Count	44	0	44
		% within ECHO	100%	0%	
		% within CAG	58%	0%	
	-	Count	32	24	56
		% within ECHO	57%	43%	
		% within CAG	42%	100%	
Total		Count	76	24	100

p=<0.0005

Sensitivity= 82% Specificity=91% Positive predictive value=92% Negative predictive value= 81%

There is significant difference in 2 D ECHO findings of patients with CAG evidence of RCA and no evidence of RCA occlusion.

Number of patients who had evidence of inferior wall hypokinesia are 50. Number of patients who had no evidence of inferior wall hypokinesia are 50. Number of patients who had evidence of RCA artery are 56. Number of patients who had no evidence of RCA artery are 4 (Table 9).

Table 9: Correlation of 2D ECHO changes with CAG in RCA artery occlusion. CAG (RCA) * ECHO Crosstabulation(B)

			CAG(RCA)		
			+	-	Total
ECHO	+	Count	46	4	50
		% within ECHO	92%	8%	
		% within CAG	82%	8%	
	-	Count	10	40	50
		% within ECHO	18%	91%	
		% within CAG	20%	80%	
Total Count			56	44	100

p=<0.0005

Table10: Correlation of 2D ECHO changes with CAG in LCx artery occlusion CAG (LCX) * ECHO Cross tabulation.

			CAG(LCx)		
			+	-	Total
ECHO	+	Count	24	26	50
		% within ECHO	48%	52%	
		% within CAG	52%	48%	
	-	Count	22	28	50
		% within ECHO	44%	56%	
		% within CAG	48%	52%	
Total		Count	46	54	100

p=1ns

ECHO+ = ECHO showing inferior/lat. Wall hypokinesia.

ECHO- = Absence of inferior wall/lat.wall hypokinesia.

LCx+ = CAG shows LCx artery occlusion LCx- = CAG does not show LCx artery occlusion

Sensitivity= 52%Specificity=52%Positive predictive value=48%Negative predictive value= 56%

There is no significant difference in 2 D ECHO findings of patients with CAG evidence of LCx and no evidence of LCx occlusion

Number of patients who had evidence of inferior wall hypokinesia are 50.

Number of patients who had no evidence of inferior wall hypokinesia are 50. Number of patients who had evidence of LCx artery are 46. Number of patients who had no evidence of LCx artery are 54 (Table 10).

DISCUSSION

The present study was conducted on 100 randomly selected acute ST elevation myocardial infarction patients, who underwent ECG, Cardiac enzymes, 2D ECHO and also Coronary angiogram as a part of their diagnostic procedure to identify the involved coronary artery occlusion in acute STEMI, compare them with the ECG findings and the results of the study are discussed below.

Age of presentation

The mean age of presentation in men was 53.4±12.17 years and in women was 54.5±7.16. Males formed 84% of the study and females constituted 16% of the study. In a study by Lincoff et al, the mean age of female and male patients were 61.0±9.7 years and 55.8±10.1 years respectively.[6] In a study by Wilkinson et al, 80.1% females and 59.9% men were more than 60 years old.[7]

Hypertension

Seventy four percent (64) of men and Eighty six percent (12) of women were found to be hypertensive in our study. In a study by Wilkinson et al, 741.7% women and 27.3% men were hypertensive. In another study by Jenkins et al, 46.5% females and 34.4% males were hypertensive.[7,8]

Diabetes

Fifty men (58%) and twelve (86%) women were found to be diabetic in this study. Bueno et al, reported that 41% of the female patients and 18% of the male patients were diabetic in their study.[9] In a study conducted by Ramesh Babu they found the incidence of diabetes mellitus to be 40.8% in the elderly female patients.[10]

Smoking

In this study76% of the male patients were smokers and 56 % of the male patients consumed alcohol regularly, keeping with the cultural practice none of the women were found to be smokers neither consumed alcohol. In a study by Wilkinson et al,741.7% women and 51.98% of men were smokers. Another study by Jenkins et al,8it was found that women smoked less than men (54.9% vs 69.0%).

Coronary angiogram

Coronary angiogram analysis in the present study revealed the presence of SVD in 38% of the patients, 46% of the patients had DVD and 16% of the patients had TVD. Seventy-six (76%) patients showed evidence of LAD artery involvement by CAG of which 46 patients had ECG features suggestive of LAD artery involvement.

Fifty-six (56%) patients showed evidence of RCA territory involvement by CAG of which 44 patients had ECG features suggestive of RCA artery involvement. Forty-six (46%) patients showed involvement of LCx artery involvement of which only 12 patients met the ECG criteria.

In a study by Pichard et al, they found that the IRA was LAD in 47% which was similar to present study, RCA in 50% and IRA as LCx was seen in 3%, while this study showed an increased incidence of LCx artery involvement and relatively lesser incidence of RCA involvement.[11]

Role of echocardiography

Correlation of 2D-ECHO with CAG

The regional wall motion abnormality was detected with the help of 2D-ECHO and it was found that in 88% of the patients there was evidence of hypokinetic, dyskinetic or akinetic segment; however, in 12% of the patients no regional wall motion abnormalities were detected.

The sensitivity of 2D-ECHO in detecting the anterior or anteroseptal wall regional wall motion abnormality when there is CAG evidence of LAD occlusion in this study was 58% and the specificity, PPV and NPV were 100%,100% and 43% respectively.

The sensitivity, specificity, PPV and NPV of ECG in identifying inferior wall RWMA in relation to the angiographic evidence of RCA artery involvement were 82%, 91%, 92% and 81% respectively and the sensitivity, specificity, PPV and NPV of ECG in identifying inferior wall RWMA when there was angiographic evidence of LCx artery involvement were 52%, 52%, 48% and 56% respectively.

The sensitivity, specificity, PPV and NPV of ECG in identifying lateral wall RWMA when there is angiographic evidence of LCx artery involvement are 9%, 92.5%, 50% and 54% respectively. There was no significant difference noted in 2D ECHO findings in patients with and without LCx artery occlusion in the present study.

In a study conducted by Richard et al, they found that 94% of the patients with transmural or nontrans mural myocardial infarction had a regional wall motion abnormality and 100% of the patients with clinical transmural MI were predicted with the use of 2D ECHO and the patients with false positive regional wall motion abnormality demonstrated coronary artery block on subsequent angiography.[12] They also found that none of

the patients with normal regional wall motion on admission had a complicated course.

Correlations of ECG changes with 2 D ECHO

The sensitivity and specificity of ECG in correlation with RWMI identified by 2D ECHO in Anterior wall MI was 95% and 93% respectively. The PPV and NPV was found to be 91% and 96% respectively.

The sensitivity and specificity of ECG in correlation with RWMI identified by 2D ECHO in Lateral wall MI 75% and 91%. The PPV and NPV was found to be 43% and 97% respectively, however there was no significant difference in the ECG findings between patients who had evidence of lateral wall hypokinesia and in patients who did not have lateral wall hypokinesia.

Inferior wall hypokinesia was found in 50(50%) of the patients, of which 38(76%) patients showed ECG features suggestive of RCA artery occlusion. The sensitivity, specificity, PPV and NPV of ECG in correlation with RWMI identified by 2D ECHO in Inferior wall MI was 76%,80%,79% and 77% respectively.

CONCLUSION

The admission ECG in patients with ST elevation acute myocardial infarction is valuable not only for determining who should and should not receive early reperfusion treatment, but also for providing information regarding the location and extent of acute myocardial injury. In the presence study we conclude that the ECG was found to be a sensitive and specific tool in identifying the involved coronary artery in acute ST elevation MI and gives important information to guide management and to determine the prognosis of patients. The electrocardiographic markers of proximal coronary artery occlusion help us identify large myocardial infarctions that may benefit from early revascularization strategies.

ACKNOWLEDGEMENTS

REFERENCES

1. Pearson TA. Cardiovascular disease in developing countries: Myths, realities and opportunities. Cardiovasc Drugs Ther. 1999;13(2):95-104.
2. Deshpande S, Lokhandwala Y. API expert consensus document on management of ischemic heart disease. J Assoc Physic India. 2006 Sep;54:748.
3. Xavier D, Prem P, Devereaux PJ, Xie C, Prabhakaran D et al. Treatment and outcomes of acute coronary syndromes in India(CREATE): a prospective analysis of registry data. Lancet. 2008Apr;9622(371):1435-42.
4. Zimetbaum PJ, Josephson ME. Use of the Electrocardiogram in Acute Myocardial infarction. New Eng J Med. 2003Mar;(348):933-40.
5. Clemmensen P. Electrocardiographic evaluation of reperfusion therapy in patients with acute myocardial infarction. Dan Med Bull. 1996 Feb;43(1):68-85.
6. Lincoff AM, Califf RM, Ellis SG, Sigmon KN, Lee KL, Leimbergerphd JD, et al. Thrombolytic therapy for women with myocardial infarction: is there a gender gap?. J Am Coll Cardiol. 1993 Dec 1;22(7):1780-7.
7. Wilkinson P, Laji K, Ranjadayalan K, Parsons L, Timmis AD. Acute myocardial infarction in women: survival analysis in first six months. BMJ. 1994 Sep 3;309(6954):566-9.
8. Jenkins JS, Flaker GC, Nolte B, Price LA, Morris D, Kurz J, et al. Causes of higher in-hospital mortality in women than in men after acute myocardial infarction. Am J Cardiol. 1994 Feb 15;73(5):319-22.
9. Bueno H, Vidan T, Almazar A, Lopez-Sendon JL Delcan JL. Influence of sex on the shortterm outcome of elderly patients with a first acute myocardial infarction. Circulat. 1995;92:1133-40.
10. Ramesh BB. Coronary heart disease in women with special reference to young women. JAPI. 1984;32:48
11. Pichard AD, Ziff C, Rentrop P, Holt J, Blanke H, Smith H. Angiographic study of the infarct-related coronary artery in the chronic stage of acute myocardial infarction. Am Heart J. 1983 Oct 1;106(4):687-92.
12. Horowitz RS, Morganroth J, Parrotto C, Chin C, Soffer J, Ferrel J. Pauletto; Immediate Diagnosis of Acute Myocardial Infarction by Two-dimensional Echocardiography. Circulat. 1982:65(2)323-9.