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RESEARCH ARTICLE

TO STUDY OF PATTERN OF ECG FINDING IN PATIENTS UNDERGOING CORONARY ANGIOGRAPHY

Dr. Ram Gopal Saini[1,*], Dr. Anoop kumar[2] and Dr. Ajay Mathur[3]

Department of Medicine, SMS Medical College, Jaipur, Rajasthan, India

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ABSTRACT

Introduction: Cardiovascular disease has emerged as a major health burden in developing countries. atherosclerotic disease of the coronary arteries is the most common cause of luminal narrowing there are multiple non atherosclerotic causes to it and the subsequent clinical coronary events. ECG is used to diagnose and predict the culprit artery and also level of occlusion in the culprit artery in patients with myocardial infarction. . We evaluated the set of criteria described by Fiol *et al* and another set of criteria described by Engelen *et al* as to how well they predict the level of occlusion in the culprit artery. Aim and Objective To assess the pattern of ECG finding among CAD patient with different severity detected by coronary angiography. **Material and methods:** This is a hospital based prospective study conducted in SMS hospital, Jaipur with patient of acute coronary syndrome (STEMI) from April 2014 to April 2015. Total number of cases was 100. Patients satisfying inclusion criteria underwent coronary angiogram. Data of patients underwent coronary angiogram were co-related with ECG changes. Correlation of CAG finding and ECG changes was done. Qualitative and quantitative morphologic analysis done and results were interpreted accordingly. **Results:** Majority of the patients were above the age of 50 years (35%). There were 87% males and 13% females. 34% of the patients had hypertension, 29 % were diabetics, 32% were smokers, 41% were dyslipidemic and 48% of patients of age 55 or above. 74 patients of anterior wall MI had LAD as culprit artery, with 11 patients had additional lesion in the left circumflex and 8 patients in right coronary artery i.e 15% patients had LCx & 11% had RCA. Of 14 patients had two vessels disease and 5 patients had triple vessels disease. 26 patients of inferior wall MI, of 22 patients having right coronary artery as the culprit artery, 3 patients had additional lesion in left anterior descending artery and 2 patients in posterior descending artery. **Conclusion:** ECG have excellent sensitivity, specificity and exhibits good correlation and agreement with CAG to predict the culprit artery.

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INTRODUCTION

It is widely acknowledged that cardiovascular disease (CVD) and stroke are the leading causes of death and disability (World Health Organization, 2012). CVD is responsible for about 30 percent of all deaths worldwide each year. Nearly 80 percent of these deaths occur in developing countries. Indeed, CVD is the leading cause of mortality in almost every region of the world (Reddy, 2004). Acute myocardial infarction is one of the common cause of death all over the world. Non communicable diseases have overtaken communicable diseases as the world's major disease burden, with CVD remaining the leading global cause of death, accounting for 17.3million deaths per year, a number that is expected to grow to 23.6 million by 2030. It is predicted that more than half the world wide cardiovascular disease risk burden will be borne by the Indian subcontinent in the next decade according to recent epidemiological studies (Gupta, 2008). Cardiovascular disease has emerged as a major health burden in developing countries.[2] Cardiovascular risk factors for acute coronary syndrome (ACS) are on the rise in people of Indian origin and ACS is now the leading cause of death (Gupta, 2006). In addition to high rates of mortality, CVD manifests in low and middle income countries almost 10 year earlier than other countries.[3] Studies carried out in India and other places suggest that Asians in general and Indians in particular are at increased risk of Myocardial Infarction at a younger age (<40years) (Yusuf *et al*., 2004). There is a rising incidence of acute MI in young adults (Akram, 2003). Young patients are more likely to have a history of smoking and dyslipidemia, but less likely to have other comorbidities such as diabetes mellitus, hypertension, or prior coronary artery disease and have fewer diffuse atherosclerotic coronary arteries (Zimmerman, 1995; Barbash, 1995).

Corresponding author: **Dr. Ram Gopal Saini,**
Department of Medicine, SMS Medical College, Jaipur, Rajasthan, India.

Identification and management of risk factors should be conceived as prevention or treatment of the atherosclerotic disease process itself and as such, should be included as an integral part of any management plan for the many acute or chronic manifestation of this disease. The Considering the feasibility and' efficacy of risk factor modification certain guidelines have been laid by American Heart Association (National Cholesterol Education Program) (National Cholesterol Education Program, 1994) for both primary prevention and secondary prevention (Egred, 2005). Although atherosclerotic disease of the coronary arteries is the most common cause of luminal narrowing there are multiple non atherosclerotic causes to it and the subsequent clinical coronary events (Huang, 2013; Chua, 2010; Teixeira, 2010). ECG is generally used to diagnose myocardial infarction. However, it can also be used to predict the culprit artery and also level of occlusion in the culprit artery in patients with myocardial infarction. Various ECG criteria have been studied in the past to predict the culprit artery and also the level of occlusion in the culprit artery (Zimetbaum, 1998). If the level of occlusion is located proximally in the culprit artery, the extent of myocardial damage is likely to be large. By identifying a proximal lesion, the ECG helps to prognosticate the patients. The patients with a proximal lesion would usually have a poorer prognosis. Hence these groups of patients would require more intensive monitoring and they would benefit from a more aggressive therapy including early invasive therapy (Herz, 1997). There are many sets of criteria that are helpful in predicting the level of occlusion in LAD, RCA or LCx and nearly all such studies have been done in the western population. We evaluated the set of criteria described by Fiol *et al* and another set of criteria described by Engelen *et al* as to how well they predict the level of occlusion in the culprit artery (Fiol, 2009; Engelen, ?).

Aim and Objective: To assess the pattern of ECG finding among CAD patient with different severity detected by coronary angiography

MATERIAL AND METHODS

This is a hospital based prospective study conducted in SMS hospital, Jaipur with patients of acute coronary syndrome (STEMI) from April 2014 to April 2015. Total number of cases was 100.

Inclusion Criteria

- Patients of chest pain who had clinical & ECG finding s/o new onset STEMI and managed accordingly & subsequently underwent angiography at SMS hospital
- Informed consent.

Exclusion Criteria

- Patients with acute STEMI, but not willing for undergoing Coronary Angiogram.
- Patients who underwent prior coronary arterial bypass surgery.
- Patients with NSTEMI

Patients satisfying inclusion criteria were recruited. Selective coronary angiogram was performed within 5 to 15 days of presentation.

Data of patients underwent coronary angiogram were co-related with ECG changes. Correlation of CAG finding and ECG changes was done. Qualitative and quantitative morphologic analysis done and results were interpreted accordingly.

RESULTS AND DISCUSSION

Majority of the patients were above the age of 50 years (35%). There were 87% males and 13% females. Hypertension, diabetes mellitus, smoking, dyslipidemia and age were taken into consideration as risk factors for coronary artery disease and myocardial infarction. 34% of the patients had hypertension, 29 % were diabetics, 32% were smokers, 41% were dyslipidemic and 48% of patients of age 55 or above. In above table 74 patients of anterior wall MI, 22 inferior wall MI and 4 patients were inferior wall MI with right ventricular MI.
In above table 74 patients of anterior wall MI had LAD as culprit artery, with 11 patients had additional lesion in the left circumflex and 8 patients in right coronary artery i.e 15% patients had LCX & 11% had RCA. Of 14 patients had two vessels disease and 5 patients had triple vessels disease. Above Table (3) Show total 26 patients of inferior wall MI, of 22 patients having right coronary artery as the culprit artery, 3 patients had additional lesion in left anterior descending artery and 2 patients in posterior descending artery i.e 12% had LAD & 8% PD. Of 2 patients had two vessels disease and one patient had triple vessels disease.

On comparing above two table we found that frequency of LAD: RCA: 3:1 We study 100 patients of 16 (16%) patients had two vessels disease and 6 (6%) triple vessels disease. Thus marked ST depression in III, aVF (Sum of ST depression in III and aVF $\geq$ 2.5 mm) was found to have high specificity(85%) for a occlusion proximal to D1 but with a low sensitivity of 28 % with PPV 83 & NPV 30. On the other hand an elevated or isoelectric ST segment in III, aVF has moderate sensitivity and moderate specificity (65% and 69% respectively) for an occlusion distal to D1 with PPV 43 & NPV 84. In our study, LAD was the culprit artery in 74 patients. Out of these, 55 patients had isolated LAD occlusion, whereas 19 patients had additional lesions (in RCA or LCx). We have applied the criteria described by Fiol *et al* to all the 74 patients, irrespective of whether they had isolated LAD occlusion or additional lesions and the results obtained are as mentioned above. However, In the original study, Fiol *et al* studied only patients with isolated LAD occlusion and derived the criteria. Hence we selected a subgroup of 55 patients with isolated LAD occlusion and evaluated the performance of Fiol *et al*'s [16] criteria among them.

Fiol *et al*, showed the sensitivity, specificity, PPV, NPV of criteria described in predicting the level of occlusion in the subgroup of 55 patients of our study population who had isolated LAD occlusion. We find that whether the criteria are applied all patients with LAD occlusion with or without additional lesions or are applied to only to those with isolated LAD occlusions the results were similar. The Sensitivity, Specificity, Positive Predictive Value and Negative Predictive Values of different ECG criteria described by Fiol *et al* for predicting level of occlusion patients with LAD culprit lesion (74 patients : 55 with isolated LAD lesion and 19 with additional lesions in other arteries).

Table 1: Type of MI as per ECG Changes

S. No.	ECG change (ST elevation in leads)	Type of MI	Number of Patients
1.	V3-V4	Anterior wall MI	37
2.	V1-V3 or V4	Anteroseptal MI	22
3.	V3 -V6 and I and Avl	Anterolateral	15
4.	II,III and Avf	Inferior wall MI	22
5.	II, III, aVF and V1 ,V4R	Inferior wall MI with Right ventricular MI	4
Total patients			100

Table 2: Culprit artery for AWMI as per ECG changes and cart

S. No.	Type of MI According ECG	No. of patients	CART FINDING				
			LAD	Additional occluded vessels			
				RCA	LCx	Two VD	T VD
1.	Anterior wall MI	37	37	3	2	5	0
2.	Antero septal MI	22	22	2	4	5	3
3.	Anterolateral	15	15	3	5	4	2
Total		74	74	8	11	14	5

Table 3: Culprit artery for IWMI as per ECG changes and CART:

S. No.	Type of MI According ECG	No. of patients	CART Finding					
			RCA	LCX	Additional occluded vessel			
					PD	LAD	Two VD	T VD
1.	Inferior wall MI	22	18	4	2	3	2	1
2.	Inferior wall MI with Right ventricular MI	4	4	0	0	0	0	0
Total		26	22	4	2	3	2	1

Table 4. Culprit artery as Per ECG and Angiogram:

ECG criterion ST in III, aVF.	Total no of patients Fulfilling the ECG criterion	FINDINGS AS PER ANGIO	
		Lesion proximal to D1	Lesion distal to D1
Σ ST depression III + aVF ≥ 2.5 (predicts occlusion proximal to D1)	18	15	3
ST segment in III and aVF isoelectric or elevated (predicts occlusion distal to D1)	30	17	13
Σ ST depression in III + aVF ≤ 2.5 and ≥ 0.5 (indeterminate group –lesion could either be proximal or distal to D1)	26	22	4
Total	74	54	20

ECG Criteria	Sensitivity	Specificity	PPV	NPV
Ability of Σ ST depression in III + aVF ≥ 2.5 to predict lesion proximal to D1	28	85	83	30
Ability of ST elevated or isoelectric in III + aVF to predict lesion distal to D1	65	69	43	84

ECG Criteria	Sensitivity	Specificity	PPV	NPV
Ability of Σ ST depression in III + aVF ≥ 2.5 to predict lesion proximal to D1	28	87	85	31
Ability of ST elevated or isoelectric in III and AVF to predict lesion distal to D1	67	70	45	85

Table 5: Comparison of our study with Fiol's study

ECG Criteria	Our Study Results				Fiol *et al* Study Result			
	Sensitivity	Specificity	PPV	NPV	Sensitivity	Specificity	PPV	NPV
Ability of Σ ST depression in III + aVF ≥ 2.5 to predict lesion proximal to D1	28	85	83	30	77	84	92	61
Ability of ST elevated or isoelectric in III + aVF to predict lesion distal to D1	65	69	43	84	44	100	100	70

Table 6. Comparison of our study with Fiol study in isolated LAD occlusion

ECG Criteria	Our Study Result				Fiol *et al* Study Result			
	Sensitivity	Specificity	PPV	NPV	Sensitivity	Specificity	PPV	NPV
Ability of Σ ST depression in III + aVF ≥ 2.5 to predict lesion proximal to D1	28	87	85	31	77	84	92	61
Ability of ST elevated or isoelectric in III and AVF to predict lesion distal to D1	67	70	45	85	44	100	100	70

Table 7. Engelen *et al*, predicting the lesion proximal to D1 in LAD occlusion

ECG Criteria	Sensitivity	Specificity	PPV	NPV
ST depression II ≥ 1	28	95	94	33
ST depression III ≥ 1	50	75	84	36
ST depression III ≥ 2.5	13	100	100	30
ST depression aVF ≥ 1	44	80	86	35
ST depression aVF ≥ 2	15	100	100	30

Table 8: ECG predictors of LAD occlusion proximal to D1 (Engelen *et al* criteria)

ECG Criteria	Our Results				Results in Engelen *et al*'s original study			
	Sensitivity	Specificity	PPV	NPV	Sensitivity	Specificity	PPV	NPV
ST Dep II ≥1	28	95	94	33	34	98	93	68
ST Dep III ≥ 1	50	75	84	36	66	75	64	76
ST Dep III≥ 2.5	13	100	100	30	32	95	81	67
ST Dep aVF ≥ 1	44	80	86	35	54	85	71	72
ST Dep aVF ≥ 2	15	100	100	30	27	97	85	66

Table 9: Culprit artery in inferior MI as per ECG changes and angiogram

S. No.	Clinical Diagnosis	No. of Patients	Surface ECG ST Elevation	ECG Criteria	No. of Patients full filling ECG Criterion	Culprit artery as per our ECG criterion	Culprit artery as per coronary angiogram	
1.	Inferior wall MI	22	ST elevation in II, III, and aVF	ST elevation III > II	18	RCA	RCA Proximal to RV	RCA distal to RV
							13	5
				ST elevation in II > III	4	LCx	4	
2.	Inferior wall MI with Right ventricular MI	4	ST elevation in II, III, aVF and V1 & V4R	ST elevation in V1 and V4R	4	RCA Proximal To RV	RCA Proximal to RV	RCA Distal to RV
							3	1
3.	Total	26		26			20	6

Table 10: Culprit artery for IWMI as per ECG and Angiography

S. No.	ECG Changes	ECG Criterion	No. Patients full filing ECG Criterion	As per Angiography	
1.	ST elevation in II,III & aVF	ST elevation III>II RCA	18	RCA Proximal to RV	RCA distal RV
				13	5
2.	ST elevation in II,III & aVF	ST elevation II>III LCx	4	4	
3.	ST elevation in II,III, aVF & V4R	RCA proximal to RV branch	4	Proximal to RV	Distal to RV
				3	1

The marked ST depression in III, aVF (Sum of ST depression in III and AVF ≥ 2.5 mm) was found to have high specificity(85%) for a occlusion proximal to D1 but with a low sensitivity of 28 % with PPV 83 & NPV 30. On the other hand an elevated or isoelectric ST segment in III, aVF has moderate sensitivity and moderate specificity (65% and 69 % respectively) for an occlusion distal to D1 with PPV 43 & NPV 84. At the next step we evaluated the ability of Fiol *et al*'s criteria to predict the level of occlusion in a sub group of patients with isolated LAD occlusion (55 patients) excluding the patients who had additional lesions in other arteries (19 patients). The table below shows the sensitivity, specificity, PPV, NPV of criteria described by Fiol *et al* in predicting the level of occlusion in patients with isolated LAD occlusion. We found that whether the criteria were applied all patients with LAD occlusion with or without additional lesions or are applied to only to those with isolated LAD occlusions the results were similar. When we compared the results of sensitivity, specificity, PPV, NPV of Fiol *et al*'s criteria in our study population with those of the results obtained in their original study population, we find that the results are broadly similar, thus establishing the validity of Fiol *et al*'s criteria in our study population. Engelen *et al* evaluated several ECG criteria for predicting level of occlusion in LAD and we applied the same criteria in our study population and the results were as follows. In our study we found that ST depression in III ≥ 2.5 and ST depression in aVF ≥ 2 were both found to have very high specificity (100% each) for lesion proximal to D1, but very low sensitivity (13% and 15% respectively). Also ST depression in II ≥ 1 and ST depression in aVF ≥1 were found to have high specificity (95 % and 80% respectively) for lesion proximal to D1 ,but very low sensitivity (28 % and 44 % respectively).

Comparison of sensitivity, specificity, positive predictive value, negative predictive value of criteria described by Engelen *et al* in our study compared with the results in the original study. When we compare the results of sensitivity, specificity, PPV, NPV of Engelen *et al*'s criteria in our study population with those of the results obtained in their original study population, we find that the results are broadly similar, thus establishing the validity of Engelen *et al*'s criteria in our study population. 22 patients of inferior wall MI of the 18 had RCA as culprit artery, 4 as LCx culprit artery and 4 inferior wall with RVMI 3 of 4 had RCA proximal to RV & 1 had RCA distal RV branch as culprit artery.

Predicting level of occlusion in RCA: ST elevation in lead V4R suggests RCA occlusion proximal to RV branch, whereas isoelectric or depressed ST segment in V4R suggests RCA occlusion distal to RV branch. (Criterion described by Fiol M *et al* and *Bairey CN, Shah & Herz I et al)*) (Fiol, 2004; Bairey, 1987). Number of patients having RCA occlusion– 22 ST segment elevations in V4R–4 patients. In our study 22 patients had RCA as culprit artery in which 16 patients had RCA proximal to RV branch and 6 patients had occlusion RCA distal to RV branch, and 4 patients had LCx as culprit artery. In above out of the 4 patients having ST elevation in V4R, only 3 patients (75%) had occlusion proximal to RV branch of RCA as predicted by ECG (prediction correct in 3 of 4, PPV – 75%). One patient had ST depression in V4R, and he actually had occlusion distal to RV branch as predicted by the ECG.

Conclusion

The ECG is a noninvasive, easily available, diagnostic tool for the acute coronary syndrome. It have excellent sensitivity, specificity and exhibits good correlation and agreement with CAG in the prediction of culprit vessels. ECG criteria described by Fiol *et al* and those described by Engelen *et al* have low to medium sensitivity but fairly high specificity for predicting the level of occlusion in patient with LAD culprit lesion. Our results (sensitivity, specificity, PPV, NPV) are broadly similar to the results obtained by the original study by (Fiol *et al* and Engelen *et al*) in a Western population. ECG criteria described by Fiol *et al* and those described by Engelen *et al* retain validity in our study population as well, as established by this study.

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