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A Study Of Correlation Between ECG Changes And Coronary Angiogram Findings In Patients With Acute Myocardial Infarction

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Abstract

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Introduction

Myocardial infarction occurs due to occlusion of epicardial coronary arteries. The occlusion leads to necrosis of myocardial tissue and there by causes loss of function. Myocardial infarction is one of the most common causes of mortality and morbidity in both developed and developing countries. Mortality rate is higher in the first year after myocardial infarction and more specifically majority of death occurs within the first week of myocardial infarction. Mortality rate depends mainly on age, number of coronary arteries involved and the level of obstruction in the coronary artery.

Aims And Objectives

1. To study the electrocardiographic and angiographic correlation in localizing the culprit vessel in acute ST segment elevation myocardial infarction.
2. To analyse established individual electrographic parameters for their sensitivity, specificity, positive predictive value, negative predictive value in predicting the culprit vessel and level of obstruction in comparison with angiographic results.

Materials And Methods

Study centre: VIMS specialty Hospital, Salem, Tamil Nādu

Study duration: Six months.

Study design: Hospital-based, cross-sectional, observational study

Sample size: 100 cases

Inclusion Criteria For Cases:

1. Patient who presented with acute ST segment elevation myocardial infarction.
2. Patient who have undergone coronary angiography.

Exclusion Criteria For Cases:

1. Causes of ST segment elevation, other than myocardial infarction.
2. Left bundle branch block (LBBB).
3. Baseline ECG abnormalities other than LBBB (eg, paced rhythm, LV hypertrophy, Brugada syndrome).
4. Previous myocardial infarction.

Data Collection:

Patients who presented with typical chest pain were proceeded with electrocardiogram. The diagnosis of acute ST elevation myocardial infarction was made according to the following criteria:

1. Anterior wall MI: ST segment elevation by 2mm or more in two or more anatomically consequent precordial leads.
2. Inferior wall MI: ST segment elevation by 1mm or more in two or more anatomically consequent inferior leads.

Patients who full filled the above criteria and who had elevated cardiac markers were diagnosed as AWMI or IWMI and were immediately admitted in intensive cardiac care unit and immediate treatment according to the standard protocol was initiated. Angiography study was done within 15 days of admission. A total number of 100 consecutive patients who were diagnosed to have ST elevation MI were analysed. After applying the exclusion criteria, the study population was selected. We analysed 100 patients in study group. The following details and investigation reports were obtained from the patient in the study group with written informed consent.

1. Age, Sex, Occupation
2. Clinical features: Chest pain, breathlessness, palpitation, giddiness, fatigue.
3. Past history of myocardial infarction, thrombolysis, reperfusion therapy (PCI/ CABG).
4. ECG before thrombolytic therapy
5. Angiographic Report

Electrocardiographic changes in specified individual lead and the established ECG criteria for identifying the culprit artery and localizing the level of lesion were compared with angiographic localisation which is considered as gold standard. For each individual ECG criteria based on their distribution in various angiographic localisation site sensitivity, specificity, positive predictive value, negative predictive value were calculated and the p value was obtained using Fisher's exact test. Statistical analysis was done using SPSS Version 20. The following observations were made.

Results

Age And Sex Distribution:

100 patients admitted with the diagnosis of acute ST segment elevation myocardial infarction were analyzed. Of the 100 patients 88 (88%) were male and 12(12%) were female. Age and sex-wise distribution data shows that maximum number of patients were distributed in the age group of 40 to 60 years.

Age distribution

Age in years	Number of patients
<30 years	2
31-40 years	16
41-50 years	30
51-60 years	40
>61 years	12
Total	100

[Table 1]

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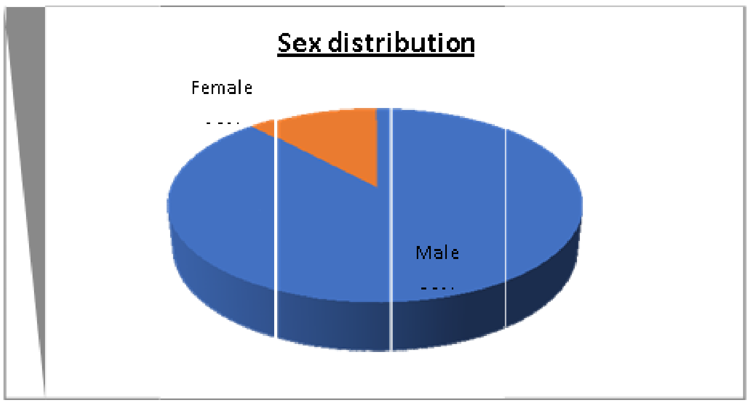
Sex distribution

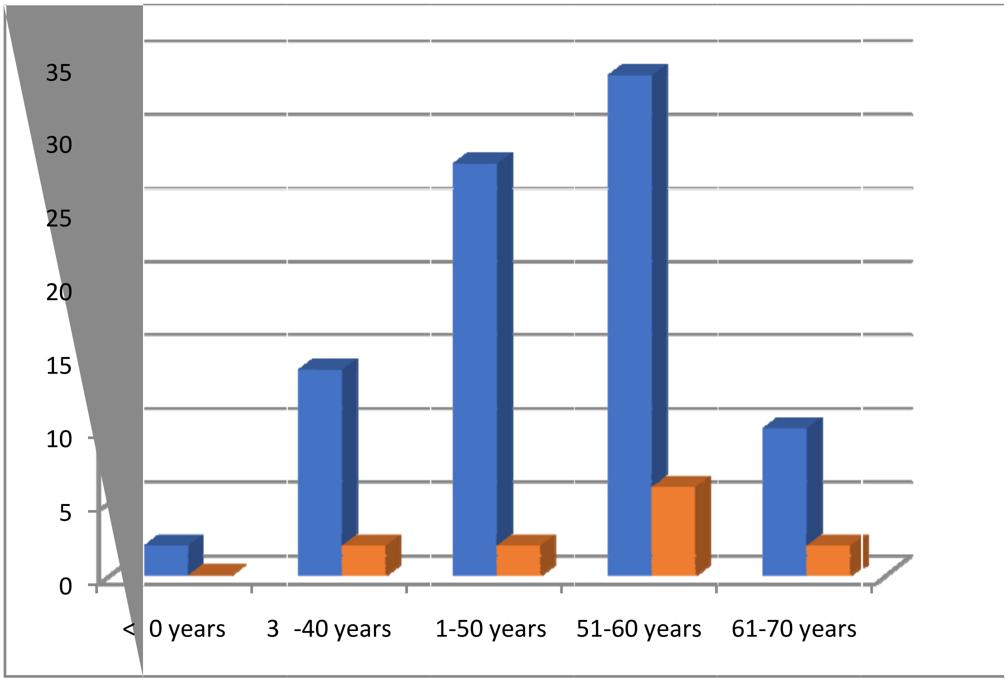
Sex	Number of patients
Male	88
Female	12
Total	100

[Table 2]



Sex distribution by age

Age in years	Male		Female		Total	
	n	%	n	%	n	%
<30	2	2.3%	0	0%	2	2%
31-40	14	15.9%	2	16.7%	16	16%
41-50	28	31.8%	2	16.7%	30	30%
51-60	34	38.6%	6	50%	40	40%
>60	10	11.4%	2	16.7%	12	12%
Total	88	100%	12	100%	100	100%

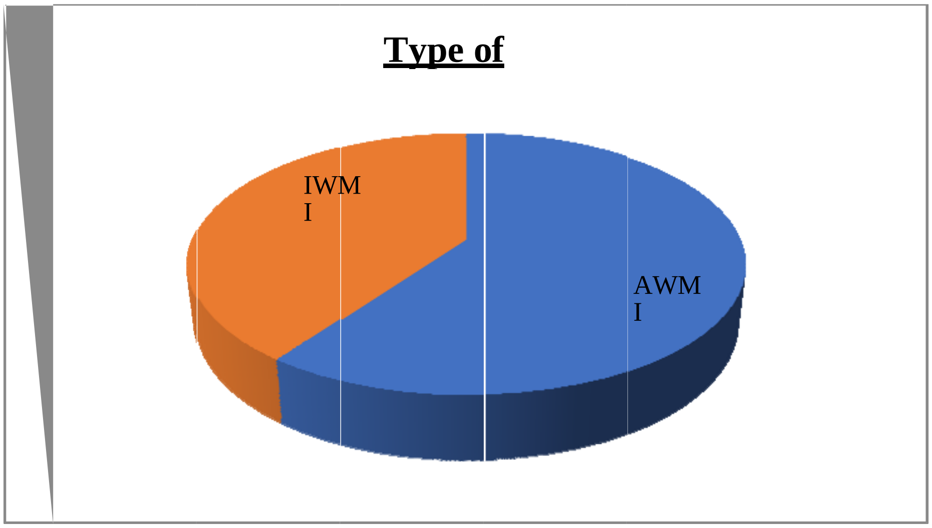


Type of MI and treatment:

Of the 100 patients with ST segment elevation MI, 60 (60%) patients had anterior wall MI (AWMI) and 40 (40%) patients had inferior wall MI (IWMI). In the 100 patients 76 (76%). Patients were thrombolysed and 24 (24%) patients were not thrombolysed.

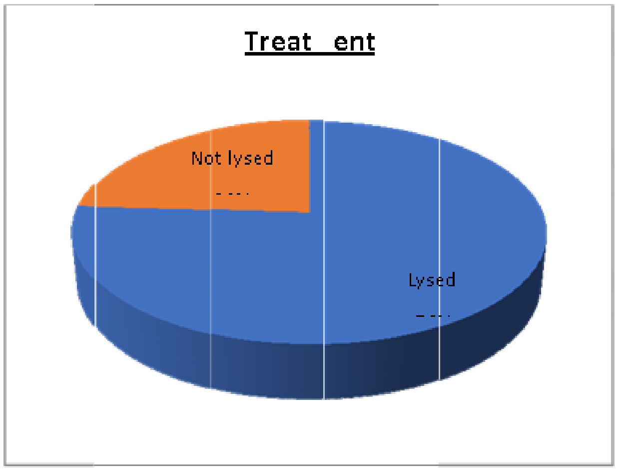
Type of MI	Number of patients	Percentage
AWMI	60	60%
IWMI	40	40%
Total	100	100%

[Table 4]



Treatment

Treatment	Number of patients	Percentage
Thrombolysed	76	76%
Not thrombolysed	24	24%
Total	100	100%



Localisation by ECG:

In our study ECG localisation for all patients was done and it showed the following results. In patients with IWMI, as per ECG, 20 (20%) patients had occlusion in proximal RCA, 12 (12%) patients had occlusion in distal RCA, and 8 (8%) patients had occlusion in LCX. In patients with AWMI 52 (52%) patients had occlusion in proximal LAD and 8 (8%) patients had occlusion in distal LAD.

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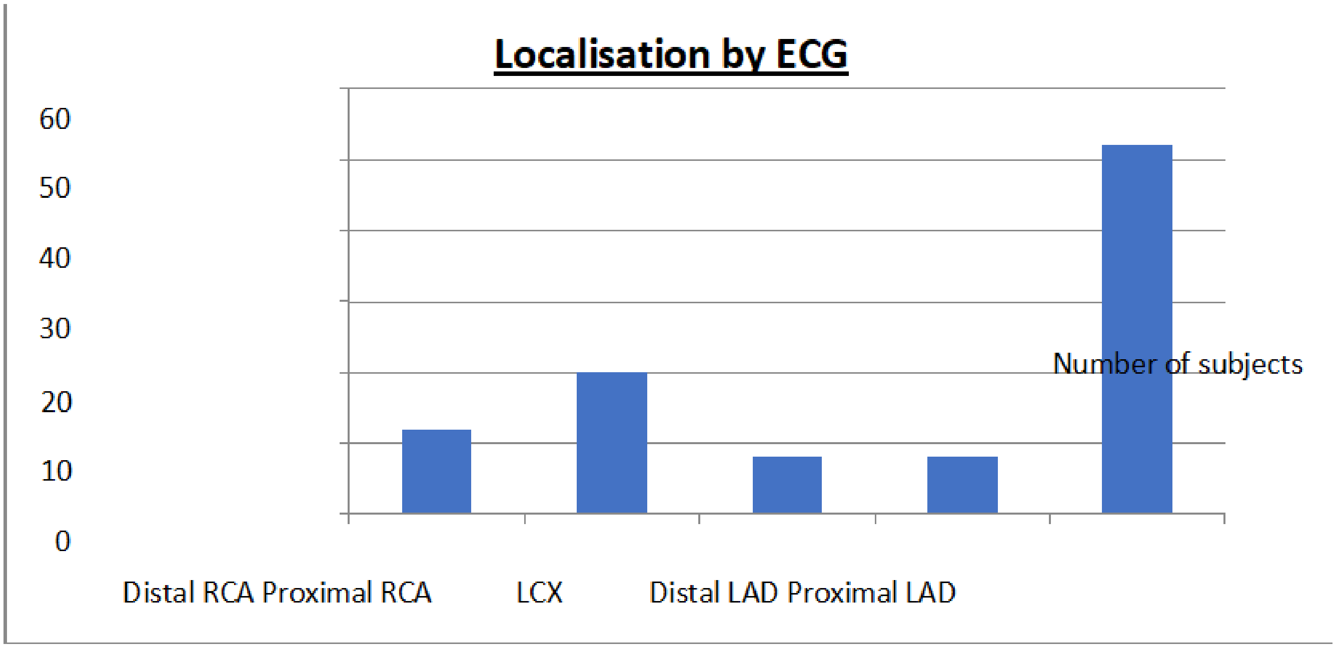
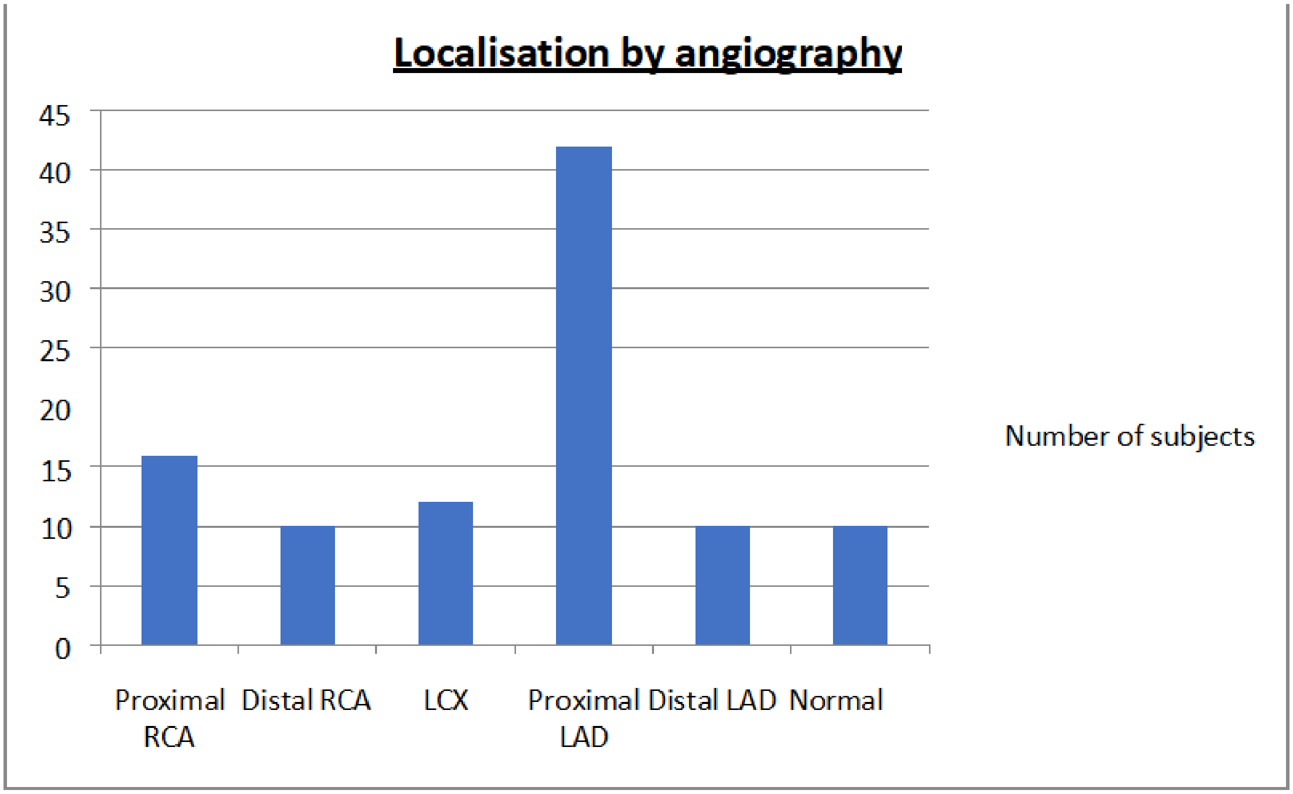
Localisation by ECG

Localisation	Number of patients	Percentage
Proximal RCA	20	20%
Distal RCA	12	12%
LCX	8	8%
Proximal LAD	52	52%
Distal LAD	8	8%
Total	100	100%



Localisation by angiography:

In our study exact site of occlusion was confirmed by angiography. It showed that 16(16%) patients had occlusion in proximal RCA, 10(10%) patients had occlusion in distal RCA, 12(12%) patients had occlusion in LCX artery, 42(42%) patients had occlusion in proximal LAD artery, 10(10%) patients had distal LAD artery occlusion and 10(10%) patients had normal coronary arteries.



ECG localisation versus angiographic localisation:

In our study by analyzing and comparing the ECG localisation with angiographic findings we found the following results.

1. Among 20 patients found to have proximal RCA occlusion by ECG, coronary angiography revealed proximal RCA occlusion in 16 patients (80%), distal RCA occlusion in 2 patients (10%), and normal coronaries in 2 patients (10%).
2. Among 12 patients found to have distal RCA occlusion by ECG, coronary angiography revealed distal RCA occlusion in 8 patients (66.7%) and LCX occlusion in 4 patients (33.3%).

ECG localisation versus angiographic localisation:

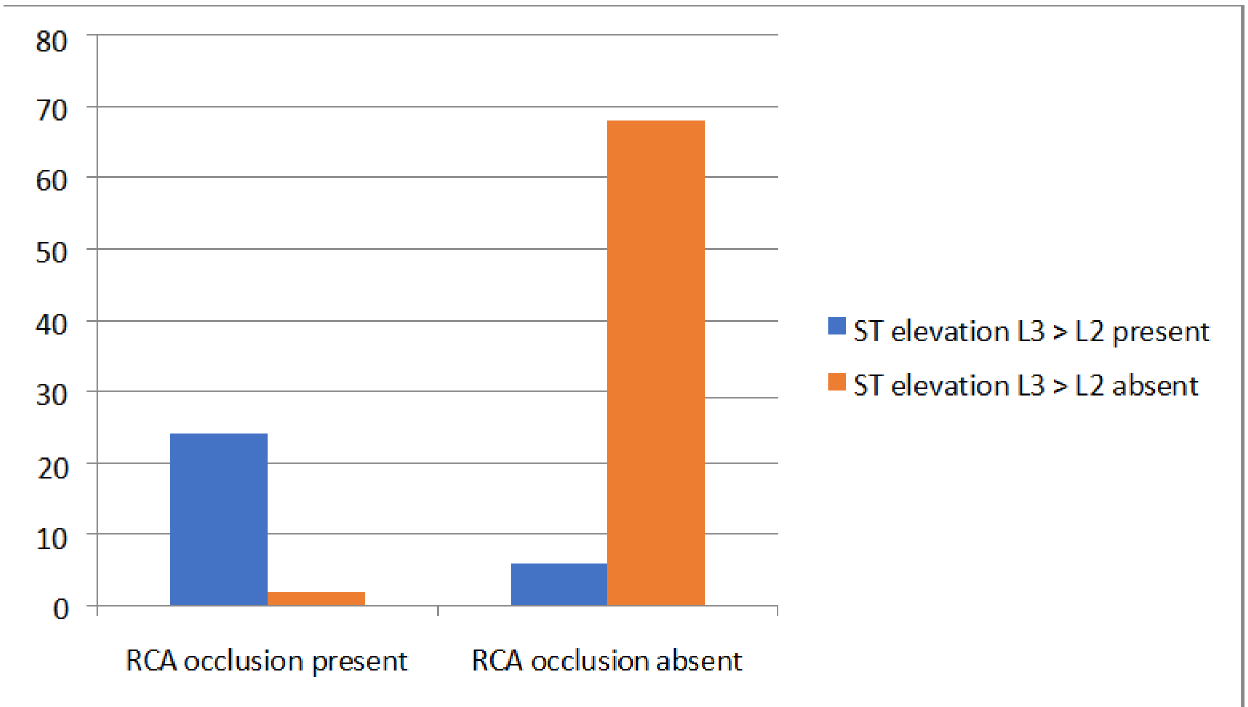
ECG localisation		Angiographic localisation						Total
		Proximal RCA	Distal RCA	LCX	Proximal LAD	Distal LAD	Normal	
Proximal RCA	Count	16	2	0	0	0	2	20
	% within ECG localization	80.0%	10.0%	0%	0%	0%	10.0%	100.0%
	% within angiographic localization	100.0%	20.0%	0%	0%	0%	20.0%	20.0%
Distal	Count	0	8	4	0	0	0	12

RCA	**% within ECG localization**	0%	66.7%	33.3%	0%	0%	0%	100.0%
	% within angiographic localization	0%	80.0%	33.3%	0%	0%	0%	100.0%
LCX	**Count**	0	0	8	0	0	0	8
	% within ECG localization	0%	0%	100.0%	0%	0%	0%	0%
	% within angiographic localization	0%	0%	66.7%	0%	0%	0%	0%
Proximal LAD	**Count**	0	0	0	38	6	8	52
	% within ECG localization	0%	0%	0%	73.1%	11.5%	15.4%	100.0%
	% within angiographic localization	0%	0%	0%	90.5%	60.0%	80.0%	52.0%
Distal LAD	**Count**	0	0	0	4	4	0	8
	% within ECG localization	0%	0%	0%	50.0%	50.0%	0%	100.0%
	% within angiographic localization	0%	0%	0%	9.5%	40.0%	0%	8%
Total	**Count**	16	10	12	42	10	10	100
	% within ECG localization	16.0%	10.0%	12.0%	42.0%	10.0%	10.0%	100.0%
	% within angiographic localization	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

ST elevation in LIII>LII in RCA occlusion on angiography

			ST elevation in LIII > LII		**Total**
			Yes	**No**	
RCA	**Yes**	Count	24	2	26

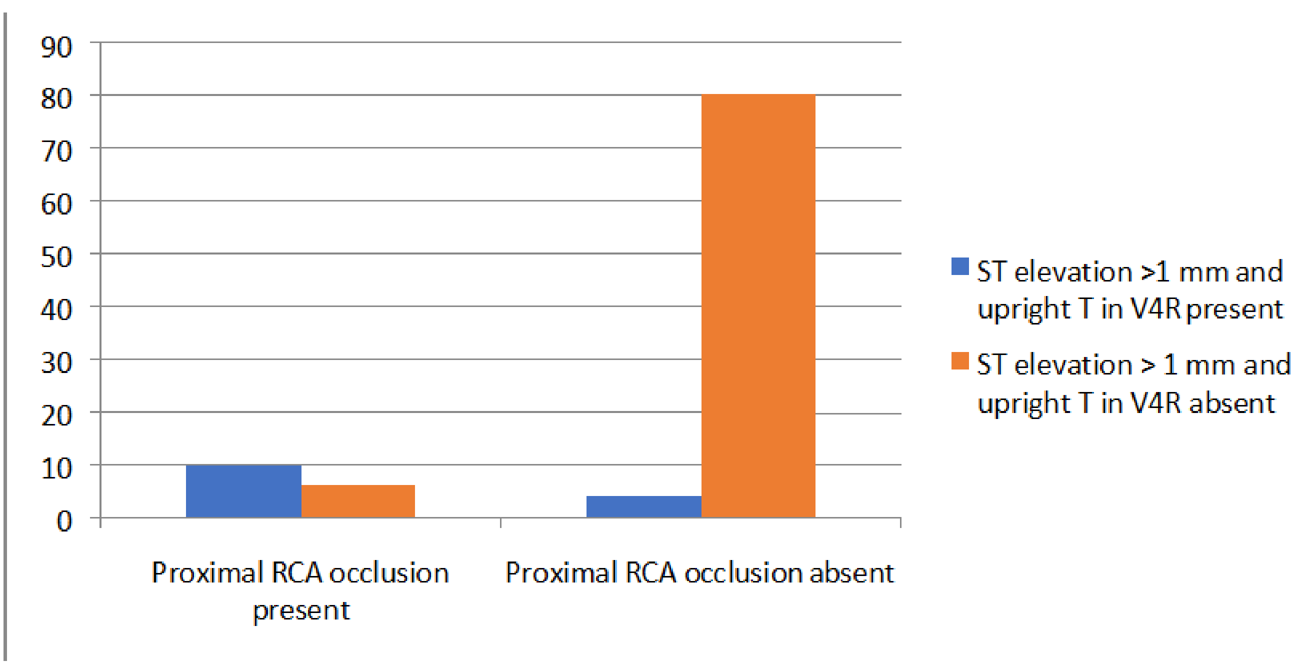
		% within RCA	92.3%	7.7%	100.0%
		% within RCA occlusion - ST elevation in LIII > LII	80.0%	2.9%	26.0%
	No	Count	6	68	74
		% within RCA	8.1%	91.9%	100.0%
		% within RCA occlusion - ST elevation in LIII > LII	20.0%	97.1%	74.0%
Total		Count	30	70	100
		% within RCA	30.0%	70.0%	100.0%
		% within RCA occlusion - ST elevation in LIII > LII	100.0%	100.0%	100.0%



The ECG finding of ST elevation LIII > LII has a sensitivity of 92.3%, specificity of 91.9%, positive predictive value of 80%, negative predictive value of 97.1% for RCA occlusion, as documented by coronary angiography (P-value <0.001).

ST elevation ≥1 mm and upright T in V4R in proximal RCA occlusion on angiography

			ST elevation ≥ 1mm and upright T in V4R		Total
			Yes	No	
Proximal RCA	Yes	Count	10	6	16
		% within Proximal RCA	62.5%	37.5%	100.0%
		% within Proximal RCA - ST elevation >= 1mm and upright T in V4R	71.4%	7.0%	16.0%
	No	Count	4	80	84
		% within Proximal RCA	4.8%	95.2%	100.0%
		% within Proximal RCA - ST elevation >= 1mm and upright T in V4R	28.6%	93.0%	84.0%
Total		Count	14	86	100
		% within Proximal RCA	14.0%	86.0%	100.0%
		% within Proximal RCA - ST elevation >= 1mm and upright T in V4R	100.0%	100.0%	100.0%



The ECG finding of ST elevation ≥1 mm and upright T in V4R has a sensitivity of 62.5%, specificity of 95.2%, positive predictive value of 71.4%, negative predictive value of 93% for proximal RCA occlusion, as documented by coronary angiography (P-value <0.001).

Discordant ST segment in V1 and V2 in proximal RCA occlusion on angiography

			Discordant ST segment in V1 and V2		**Total**
			Yes	**No**	
Proximal RCA	**Yes**	**Count**	10	6	16
		% within Proximal RCA	62.5%	37.5%	100.0%
		% within Proximal RCA - Discordant ST segment in V1 and V2	83.3%	6.8%	16.0%
	No	Count	2	82	84
		% within Proximal RCA	2.4%	97.6%	100.0%
		% within Proximal RCA - Discordant ST segment in V1 and V2	16.7%	93.2%	84.0%
Total		Count	12	88	100
		% within Proximal RCA	12.0%	88.0%	100.0%
		% within Proximal RCA - Discordant ST segment in V1 and V2	100.0%	100.0%	100.0%

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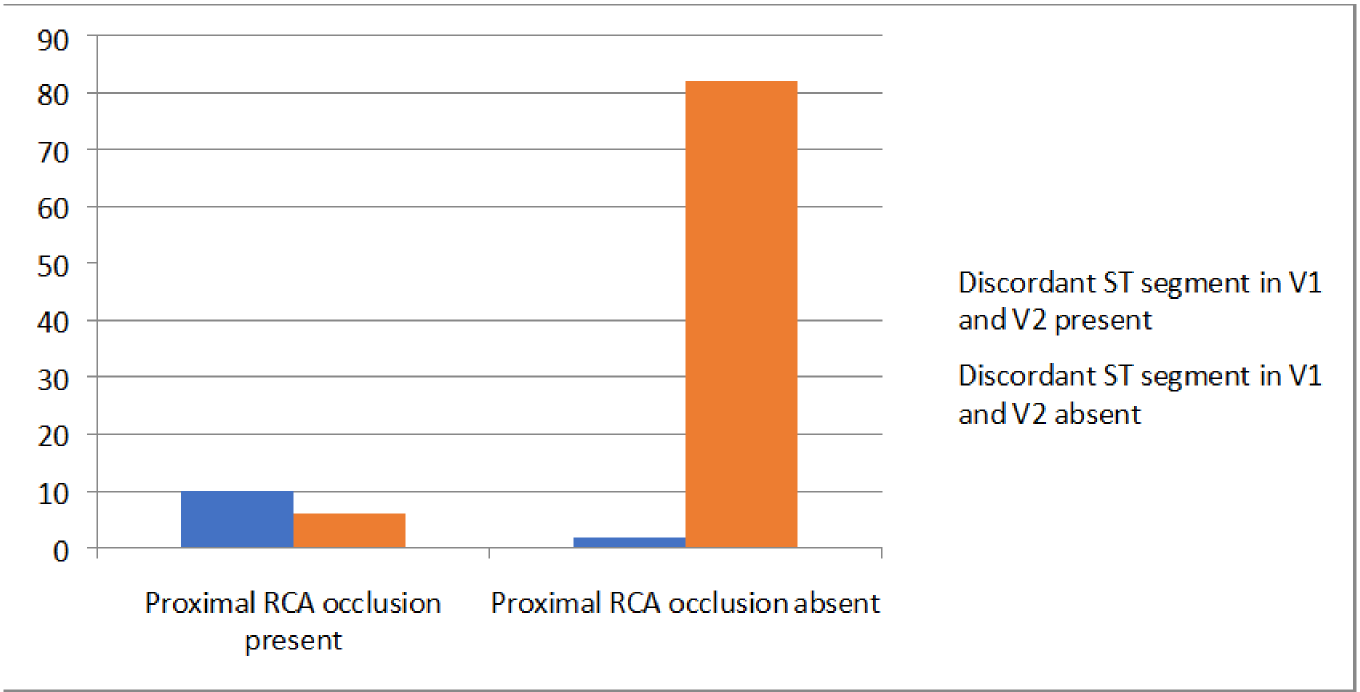

The ECG finding of Discordant ST segment in V1 and V2 has a sensitivity of 62.5%, specificity of 97.6%, positive predictive value of 83.3%, negative predictive value of 93.2% for proximal RCA occlusion, as documented by coronary angiography (P-value <0.001).

ST elevation LII > LIII in LCX occlusion on angiography:

			ST elevation LII > LIII		**Total**
			Yes	**No**	
LCX	**Yes**	**Count**	6	5	11
		% within LCX	54.5%	45.5%	100.0%
		% within LCX occlusion - ST elevation LII > LIII	100.0%	5.4%	11.1%
	No	Count	0	88	88
		% within LCX	.0%	100.0%	100.0%
		% within LCX occlusion - ST elevation LII > LIII	.0%	94.6%	88.9%
Total		Count	6	93	99
		% within LCX	6.1%	93.9%	100.0%
		% within LCX occlusion - ST elevation LII > LIII	100.0%	100.0%	100.0%

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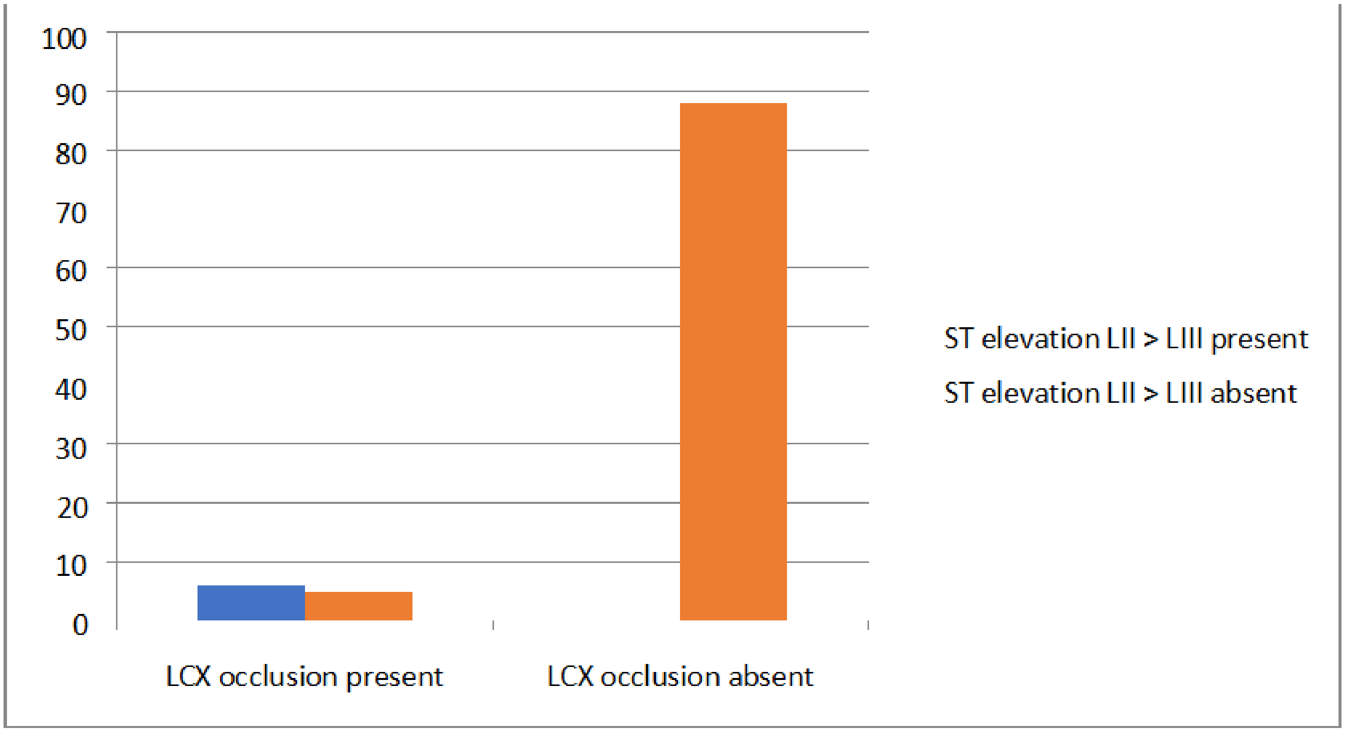

The ECG finding of ST elevation LII > LIII has a sensitivity of 54.5%, specificity of 100%, positive predictive value of 100%, negative predictive value of 94.6% for LCX occlusion, as documented by coronary angiography (P-value < 0.001).

Discussion

Myocardial infarction occurs due to sudden occlusion of epicardial coronary arteries causing ischemia and necrosis of myocytes. Myocardial infarction can be classified into either ST elevation MI or non-ST elevation MI based on the ECG. Incidence of STEMI is high in developed countries and is on the rise in developing countries. In STEMI mortality rate is 15% to 20%. One of the most important factors influencing the mortality in MI is the amount of myocardium damaged which in turn depends on the level of occlusion in the coronary arteries. When the occlusion is proximal, the tissue at risk of necrosis is more and worse is the prognosis.

ECG is useful in diagnosing ST elevation MI. Based on the indicative and reciprocal change that occur in the ECG leads, the site of coronary occlusion can be identified, and thereby we can plan aggressive therapy like Percutaneous coronary intervention or CABG. Various studies indicate that 30% of STEMI patients do not receive reperfusion therapy.

Inferior wall myocardial infarction:

Inferior wall myocardial infarction is caused by occlusion of either right coronary artery or left circumflex artery. It is diagnosed when the patient has typical chest pain, positive cardiac biomarkers, and ST segment elevation of ≥ 1 mm in lead II, III and aVF. Using standard and special leads the occlusion site can be identified.

RCA occlusion:

In their study of RCA occlusion and ECG changes Herz et al, found that ST segment elevation in lead III is more than the ST segment elevation in lead II and ST segment depression in lead aVL is more than the ST segment depression in lead I in RCA occlusion.

LCX occlusion:

Applying the criteria given by Herz et al, we found the following results in LCX occlusion. In our study ECG criteria of ST segment elevation in lead II more than the ST segment elevation in lead III had 57%, 100%, and 100%, 94% sensitivity, specificity, positive predictive value, negative predictive value respectively in predicting LCX occlusion. Our results were similar to those of Zimetbaum et al. The p value was 0.0001 and was statistically significant.

In our study one case of LCX occlusion and one case of RCA occlusion, ST segment elevation was equal in both lead III and lead II. In this setting additional changes like T wave inversion in lead V4R49 and isoelectric ST segment in lead I were useful in predicting LCX occlusion. In RCA occlusion ST segment depression in lead I and aVL was useful in localizing RCA occlusion when lead III and lead II ST segment elevation was equal.

Proximal RCA occlusion:

Similar to the work done by Zimetbaum PJ et al58 and Radhakrishnan Nair et al59 in evaluating the ECG changes of RCA and LCX occlusion, we proceeded to analyse the ECG changes of proximal RCA occlusion. For our study we have used the ECG criteria for proximal RCA occlusion given by Braat et al. Criteria for proximal RCA occlusion is ST segment elevation by equal or more than 1mm in lead V4R with a positive T wave. In our study we found that the above ECG criteria had 62.5%, 95.2%, 71.4%, 93% sensitivity, specificity, positive predictive value, negative predictive value respectively in predicting proximal RCA occlusion. The p value was less than 0.001 and it was statistically significant.

For the same proximal RCA occlusion Marriot et al have defined another set of ECG criteria namely discordant ST segment in lead V1 and lead V2 in patients with inferoposterior wall MI. So we proceeded to analyse this criteria in our study. We found that these ECG criteria had 62.5%, 97.6%, 83.3%, 93.2% sensitivity, specificity, positive predictive value, negative predictive value respectively in predicting proximal RCA occlusion. The p value was less than 0.001 and it was statistically significant.

Anterior wall myocardial infarction:

Anterior wall infarction (diagnosed when there is ST segment elevation of ≥2mm in two or more consecutive precordial leads) can be caused by occlusion of LAD at proximal, mid and distal segment. ECG is useful in predicting the occlusion site of LAD artery.

Proximal LAD occlusion:

Engelen DJ et alTamura A et al have established few criteria for diagnosing proximal LAD occlusion. Engelen DJ et al and Zimetbaum PJ et al and Martinez – Dolz et al have analysed individual ECG variables in localizing LAD occlusion with their sensitivity, specificity, PPV, NPV; we tried to analyse similar variables. In our study we found the following results.

	Sensitivity %	**Specificity %**	**PPV %**	**NPV %**	**P-value**
ST elevation V1 ≥2.5 mm	33.3	89.7	70	65	0.006
ST elevation in aVR	38.1	89.7	72.7	66.7	0.001
ST depression in LII, LIII, aVF	38.1	86.2	60.7	65.8	0.008
Q wave in aVL	38.1	79.3	57.1	63.9	0.072
RBBB	9.5	100	100	60.4	0.029

According to our results the sensitivity and NPV we obtained were very similar to the results of the study done by Engelen et al. But the PPV and specificity of our results were low compared to their study; this would be explained by the fact that we had 10 patients with MI who had normal angiographic study. Among the 10 patients 8 had ECG changes of typical proximal LAD occlusion; when we excluded such

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confounding patients from our study we got PPV and specificity similar to the study of Engelen et al.

The reason why an acute MI patient is having a normal angiography would be explained by the presence of an abnormal coronary function in the form of spasm which would have completely re-canalised after the acute event54. This usually occurs in young patients with smoking history. Engelen et al and Zimetbaum PJ et al analysed the ECG criteria for localising distal LAD occlusion that was established by Engelen et al. We analysed the same ECG criteria. Our results are

	Sensitivity %	Specificity %	PPV %	NPV %	P-value
ST elevation V2, V3, V4 with isoelectric ST segment in inferior leads	60	84.4	30	95	0.004

The results we obtained were similar to Engelen et al and Zimetbaum et al except for low PPV.

Summary

1. In our study we found that established ECG criteria were able to predict the occluded coronary arteries and were able to localise the occlusion site with significant p value.
2. In IWMI ECG criteria of ST segment elevation in lead III more than the ST segment elevation in lead II and ECG criteria of ST segment depression in lead aVL more than the ST segment depression in lead I were able to predict the occlusion site in RCA accurately. (Specificity was 91.9% and 94.6% respectively).
3. In IWMI with RCA occlusion ECG criteria of ST segment elevation by ≥1 mm with a positive T wave in lead V4R and ECG criteria of discordant ST segment in lead V1 and V2 were able to predict the occlusion level in proximal RCA accurately. (Specificity was 95.2% and 97.6% respectively).
4. In IWMI ECG criteria of ST segment elevation in lead II more than the ST segment elevation in lead III was able to predict the occlusion site in LCX accurately. (Sensitivity, Specificity, PPV, NPV were 54.5%, 100%, 100%, and 94.6% respectively).
5. In AWMI with LAD occlusion ECG criteria of ST segment elevation by ≥ 2.5mm in lead V1, ST segment elevation in lead aVR, ST segment depression in lead II, III, aVF and RBBB predicted the occlusion level in proximal LAD accurately. (Specificity was 89.7%, 89.7%, 86.2%, and 100% respectively).
6. In AWMI with LAD occlusion ECG criteria of isoelectric ST segment in inferior leads was able to localize the occlusion site in distal LAD. (Specificity was 84.4%)

Conclusion

Electrocardiogram plays an important role in diagnosing and classifying myocardial infarction. Management of myocardial infarction depends on the coronary vessel occlusion level which is identified with coronary angiography. But angiography is an invasive procedure; hence electrocardiogram with its localising value would prove a very good alternative to angiography if proved to have high localising accuracy; Specific electrocardiographic criteria are able to predict the occluded coronary artery and localise the level of occlusion. In our study 100 patients with acute ST segment elevation myocardial infarction were analysed with established electrocardiographic criteria and angiography diagnosis. We found that ECG was very useful to predict the occlusion level in the coronary artery to a statistically significant comparable level with angiographic results.

References

1. Henry Gray, Gray's Anatomy: The Anatomical basis of Clinical Practice; 40th edition: 1014-1018.

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2. Richard S. Snell's Clinical Anatomy for Medical Students; 6th edition: 101-105.
3. Third report of NCEP expert panel on the detection, evaluation and treatment of high blood cholesterol in adults.
4. Thygesen K, Alpert JS, White HD, et al. Universal definition of myocardial infarction. Circulation 116:2634,2007.
5. Assali AR, Brosh D, Vaknin-Assa H, et al. The impact of circadian variation on outcomes in emergency acute anterior myocardial infarction percutaneous coronary intervention. Cathet. Cardiovasc. Intervent. 2006; 67:221.
6. Killip T 3rd, Kimball J T. Treatment of MI in a coronary care unit. A 2 year experience with 250 patients. American journal of Cardiology 1967; 20:457-464.
7. Wu AH, Apple FS, Gibler WB, et al, National academy of clinical biochemistry standards of laboratory practice; Recommendations for the use of cardiac markers in coronary artery diseases, Clin Chem. 1999;45:1104-1121.
8. Serum marker analysis in acute myocardial infarction. American College of Emergency Physicians. Ann Emerg Med. 2000:35:534-9.
9. Bock JL, Brogan GX Jr, McCuskey CF, Thode HC Jr, Hollander JE, Gunther T Evaluation of CK-MB isoform analysis for early diagnosis of myocardial infarction. J Emerg Med. 1999; 17:75-9.
10. Canto JG, Rogers WJ, Bowlby LJ, et al. The pre-hospital ECG in acute MI, is its full potential being realized? National registry of myocardial infarction 2 investigators. J Am Coll Cardiol 1997; 29:498-505