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"THE ROLE OF ECG IN LOCALISING CULPRIT VESSEL OCCLUSION IN ACUTE ST SEGMENT ELEVATION MYOCARDIAL INFARCTION WITH ANGIOGRAPHIC CORRELATION"

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INTRODUCTION

It is widely acknowledged that heart disease and stroke are the leading causes of death and disability worldwide in developed as well as developing countries[1]. 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. MI is categorized into ST segment elevation myocardial infarction (STEMI) and non-STEMI based on ECG[2]. STEMI represents one in which a completely occlusive thrombus results in total cessation of coronary blood flow in the territory of the occluded artery and the resultant ST-segment elevation on the ECG[3]. The cause of this abrupt disruption of blood flow is usually plaque rupture, erosion, fissuring or dissection of coronary arteries that results in an obstructing thrombus.

The electrocardiogram (ECG) remains a crucial tool and cornerstone in the identification and management of acute myocardial infarction because of its repeatability, non-invasive nature, wide availability, and high diagnostic power. Acute risk stratification in myocardial infarction is still based on simple clinical parameters, laboratory markers and 12 lead electrocardiography[4.]

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[5]. Coronary angiography is another diagnostic modality, which is considered as the gold standard for identifying the infarct

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related artery in STEMI. Thus, present study aims to establish the usefulness of identifying culprit vessel in acute ST elevation pattern in myocardial infarction from ECG and correlate it with coronary angiography.

MATERIALS AND METHODS

This was a cross sectional study conducted in Dr MK Shah Medical College and Research Centre. The study enrolled a total of 112 patients.

1. INCLUSION CRITERIA

All the patients

- With acute myocardial infarction with chest pain lasting >30 mins.
- With ECG changes fulfilling the criteria for acute ST segment myocardial infarction.
- Who will undergo CT coronary angiogram after fulfilling inclusion and exclusion criteria.

2. EXCLUSION CRITERIA

- Previous myocardial infarction
- Prior CABG
- Congenital heart disease
- LBBB in baseline ECG
- Patients with a pacemaker in situ

- Appropriate detailed history regarding the case, like the type, location and duration of chest pain, associated complaints, risk factors, etc was taken and the patients were evaluated with a standard 12 lead ECG using the Phillips PageWriter TC20. Cardiac markers (ck-mb, troponins etc) and other investigations such as total lipid profile, renal function tests were ordered immediately.
- Patients were stabilised and were treated with appropriate management.

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- Patients were explained regarding the proceedings of the study and a written consent was taken.
- Patient's ECG which was taken at the time of presentation was analyzed regarding the type of MI and various criteria were applied to localise the culprit vessel occlusion.
- Those patients who had no contradictions for coronary angiogram were subjected to the same.
- Angiogram reports were collected and the infarct related artery (IRA) was identified based on total/ critical (≥70%) stenosis.
- The ECG findings were correlated with coronary angiogram findings and data was then analyzed.

RESULTS

- In our study, the mean age was 55.31 years. Maximum patients were between 51-60 years (28.5%), followed by the age group 41-50 years (25.8%). Out of 112 patients, 75 (66.9%) of them were males and 37 (33.03%) were females.
- In our study, 48 (42.8%) of them had anterior wall STEMI and 64 (57.1%) of them had inferior wall STEMI. The most common vessel involved was the RCA (46.2%) followed by the LAD (42.59%) and lastly the LCx (11.1%).
- The result of our study is summarised in the tables below :

Table 1: Distribution of various criteria on ECG:

Anterior wall STEMI		
Criteria	Number	Percentage
ST ↓II, III, aVF	39	81.25
RBBB	3	6.25

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ST ↑aVR	7	14.58
ST ↑V1 ≥2.5mm	6	12.5
Absence of ST↓ II, III, aVF	9	18.75
ST ↓aVL	6	12.5
Q V6	14	29.16
Inferior wall STEMI		
ST↑III>II	54	84.4
V4R- ST↑ with T↑	27	42.2
ST↓ I, aVL	45	70.3
ST↑ in I, aVL	6	9.4
ST↑ II>III	8	12.5
$\frac{\Sigma\downarrow ST\ V1-V3}{\Sigma\uparrow STII,III,aVF}$ >1	8	12.5
V1 ↑ ST or ↓ST < 0.5mm	33	51.6

Table 2:Analysis of criteria for Anterior wall STEMI

Criteria	Sensitivity	Specificity	PPV	NPV	P-value
lesions proximal to D1:					
ST ↓II, III, aVF	97.30	72.7	93.92	86.13	0.0012
lesions proximal to S1:					
RBBB	33.33	100	100	83.46	0.0095
ST ↑aVR	55.56	94.87	76.31	87.76	0.0044
ST ↑V1≥ 2.5mm	66.67	100	100	92.86	<0.00001
for lesions distal to D1					
Absence of ST↓ II, III, aVF	66.6	92.31	63.2	91.13	0.0005
ST ↓aVL	55.56	97.4	83.3	90.48	0.0004

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lesions distal to S1:					
Q V6	37.84	100	100	32.36	0.0206

Fig 1:Analysis of criteria for Anterior wall STEMI

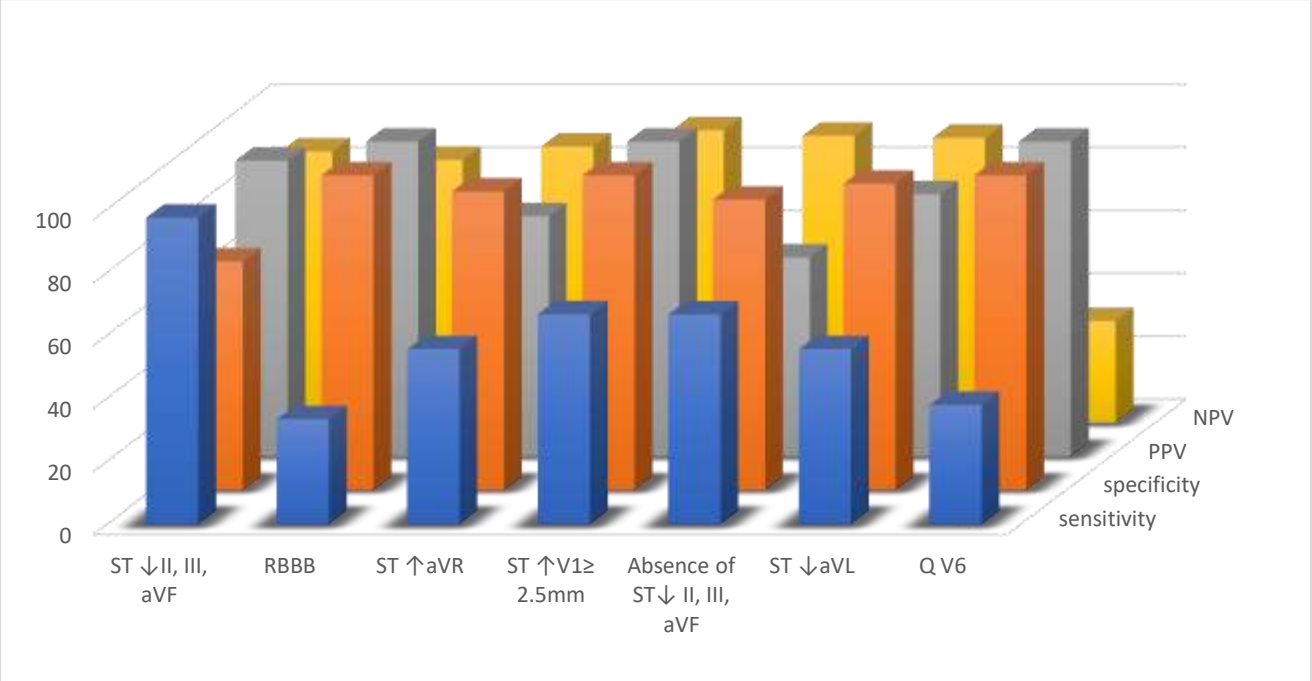

Table-3: Analysis of criteria for Inferior wall STEMI

ST change	Sensitivity	Specificity	PPV	NPV	P-value
ST changes in diagnosing RCA					
ST↑III>II	98.0	64.3	90.7	90.0	<0.001
ST↓ I, aVL	84.0	78.6	93.3	57.9	<0.001

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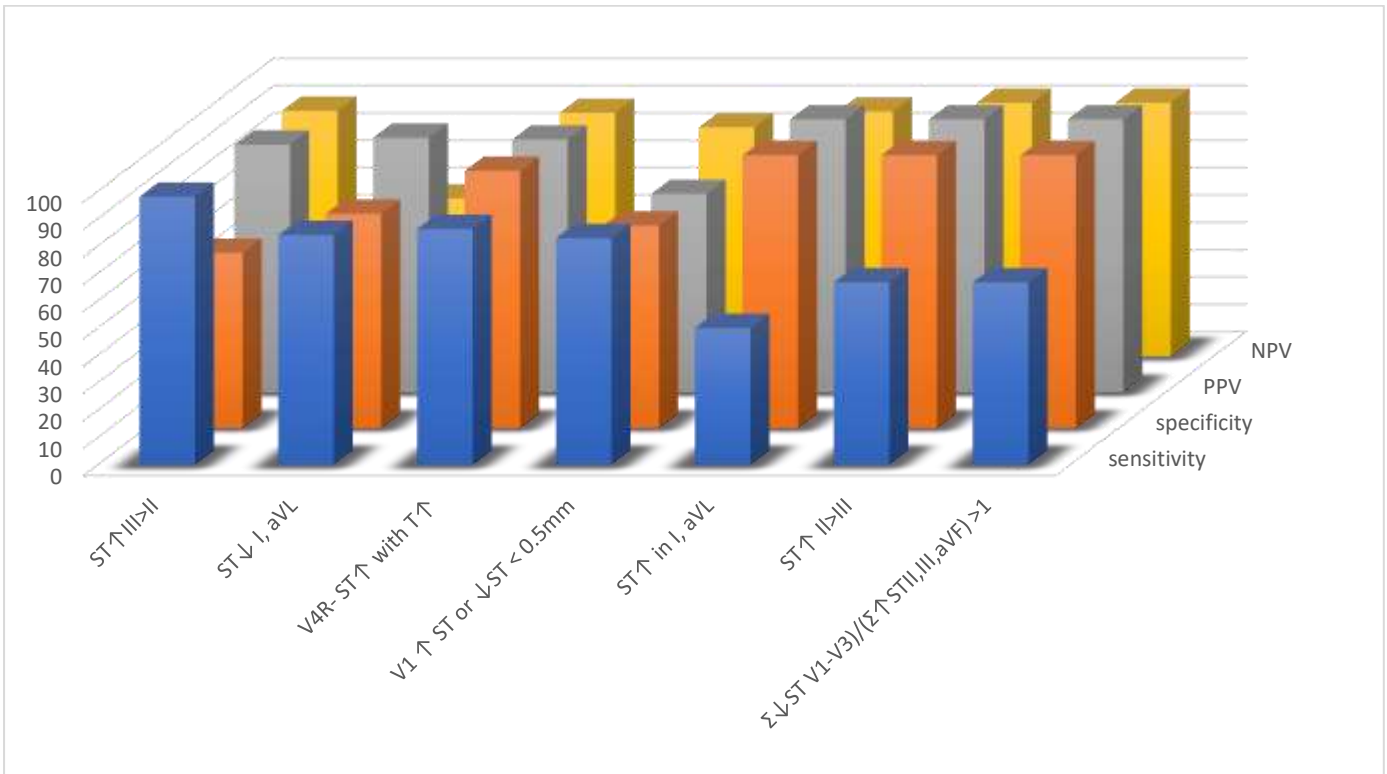
ST changes in diagnosing PRCA					
V4R- ST↑ with T↑	86.2	94.3	92.6	89.2	<0.001
V1 ↑ ST or ↓ST < 0.5mm	82.8	74.3	72.7	83.9	<0.001
ST changes in diagnosing LCX					
ST↑ in I, aVL	50.0	100.0	100.0	89.7	<0.001
ST↑ II>III	66.7	100.0	100.0	92.9	<0.001
$\frac{\Sigma\downarrow ST\ V1-V3}{\Sigma\uparrow STII,III,aVF}$ >1	66.7	100.0	100.0	92.9	<0.001

Fig 2 :Analysis of criteria for Inferior wall STEMI



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DISCUSSION

Anterior wall MI:

The total number of anterior wall MI were 48(42.8%). Based on the ECG changes and angiographic confirmation it was found that, the total number of patients with a LAD occlusion proximal to diagonal and septal branch were 6 (12.5%) and 5 (10.41%) respectively, proximal to diagonal but distal to septal branch were 33 (68.75%) and 32 (66.6%) respectively. Proximal to septal but distal to diagonal branch (anatomic variant) were 3(6.25%) and 4(8.3%) respectively, and distal to both diagonal and septal branch were 6(12.5%) and 5(10.4%) respectively. Two patients diagnosed to have LAD occlusion on ECG were found to have a normal CT angiography (4.16%). Possible explanations for this could be a prinzmetal angina or presence of a disease other than ACS causing ST elevation, or due to the effect of thrombolysis. To test the ECG criteria, patients, on the basis of their angiographic report were divided into 4 groups. Proximal to D1, Proximal to S1, Distal to D1 and S1.

Proximal to D1:

In a study by Fiol, Carrillo et al[6], they devised an algorithm to localise the site of LAD occlusion. In the study, they established that the presence of ST depression in the inferior leads> 2.5mm was quite suggestive of lesion proximal to D1 with the sensitivity, specificity, positive predictive value, negative predictive value of 77%, 84%, 92% and 61% respectively. Applying the above criteria in our study, the sensitivity, specificity, positive predictive value, negative predictive value was found to be 97.3%, 72.7%, 93.92% and 86.13% respectively. The p value was found to be significant (0.0012). Also the sensitivity and specificity of the criteria in our study was close to the sensitivity and the specificity in the study done by Vasudevan et al[7] and Markandeya et al[8], but contrary to the above studies, the sensitivity of the criteria was found to be higher than the specificity of the criteria in our study.

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Proximal to S1:

Studies done by Engelen et al[9], Markandeya et al[8] suggested that presence of RBBB was quite specific to occlusions proximal to S1. Our study showed very similar results with the Sensitivity, specificity, positive predictive value, negative predictive value and the p value being 33.3%, 100%, 100%, 83.46% and 0.0095 respectively.

ST elevation in lead aVR was specific to lesions proximal to S1 but with a low sensitivity. This was in consistence with the past studies done by Kojuri et al[10] (sensitivity- 33.9% and specificity-83.3%).

Another criterion used to determine lesions proximal to S1 was the presence of ST elevation >2.5mm in lead V1. Many studies such as those done by Kojuri et al[10], Engelen et al[9], Markandeya et al[8], have claimed this criterion to be very specific for lesions before S1. Our study revealed the sensitivity, specificity, positive predictive value, negative predictive value to be 66.6%, 100%, 100% and 92.86% respectively with a highly statistically significant p value (<0.000001). This was in accordance with the above studies.

Distal to D1:

To detect occlusion of LAD distal to D1, two criteria were applied. First one being the absence of ST depression in the inferior leads and the other being the presence of ST depression in the lead aVL.

Sensitivity, specificity, positive predictive value, negative predictive value of the criteria, 'the absence of ST depression in the inferior leads', were found to be 66.6%, 92.31%, 63.2% and 91.13% respectively. The p value was found to be significant (0.0005). Our study demonstrated similar results to the ones done by Vasudevan et al[7] and Engelen at al[9]. Also, similar results were obtained in the study done by Fiol[6] et al (Sensitivity, specificity of 44% and 100% respectively)

Many studies have also considered the presence of ST depression in aVL as a specific marker of occlusion distal to D1. In our study, on applying the

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criteria, the sensitivity, specificity, positive predictive value, negative predictive value was 55.5%, 97.4%, 83.3% and 90.48% with a significant p value of 0.0004. The high specificity, PPV and the NPV were in accordance with the studies done by Markendeya et al[8], Vasudevan et al[7]. The study done by Salunke et al[11] shows a 100% specificity for this criterion. Also, all the above studies including our study have demonstrated a significantly low sensitivity of this criteria. Thus, the presence of ST depression in aVL should raise a suspicion of lesion distal to D1 but the absence of ST depression in aVL cannot rule out the site of occlusion as distal to D1.

Distal to S1:

According to Engelen et al[9], presence of Q waves in V6 specifically suggested a lesion distal to S1. Similar result was found in our study with the sensitivity, specificity, positive predictive value, negative predictive value being 37.84%, 100%, 100% and 32.36%.

Inferior wall MI:

Inferior wall MI is caused by occlusion of either right coronary artery or left circumflex artery. It is diagnosed when the patient has typical chest pain, raised cardiac markers and an ECG showing ST elevation of 1mm in leads II, III and aVF. Using the standard and the special leads, the occlusion site can be localised. In our study, the percentage of IWMI due to RCA lesion was found to be 78.1% while LCx lesion accounted for 18.7% of the IWMI. Thus, RCA lesions were around four times more common than LCx lesions. Similar results were found in the studies done by Li et al[12] (82% RCA lesions and 17.1% LCx lesions) and Kosuge et al[13] (85.7% RCA lesions and 14.2% LCx lesions).

RCA occlusion:

In a study conducted by Fiol[14] et al, they found that in an RCA occlusion, ST segment elevation in lead III is more than the ST elevation in lead II and the

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ST depression in lead aVL and I wherein the ST depression in lead I >0.5mm is suggestive of RCA lesion.

Zimetbaum PJ et al[15]and Almansori et al[16] found that using the above criteria (ST elevation III>II), the sensitivity and specificity were 90%, 71%, and 86% and 52% respectively. Applying the above criteria in our study, we found that our results were very similar to the above studies. Our results show that for lesion due to RCA occlusion, the ECG criteria ST elevation in lead III more than II had 98%, 64.4%, 90.7% and 90% sensitivity, specificity, positive predictive value, negative predictive value respectively. The ECG criteria ST depression in leads aVL and>0.5mm had sensitivity, specificity, positive predictive value, negative predictive value of 84%, 78.6%, 93.3% and 57.9% respectively. The result was in concordance to that obtained by Fiol et al[14] (sensitivity, specificity, positive predictive value, negative predictive value of 92%, 77%, 94% and 71% respectively). The p value was statistically significant (<0.001) for both the criteria.

Proximal RCA occlusion:

For our study we have used the ECG criteria for proximal RCA occlusion given by Braat et al[17], which is ST elevation with a positive T wave in the lead V4R. Our results showed the ECG criteria having a sensitivity, specificity, positive predictive value, negative predictive value of 86.2%, 94.3%, 92.6% and 89.2% respectively with a p value of <0.001. In a study done by Nair et al[18], similar results were recorded with a sensitivity and specificity of 86% and 100% respectively.

Marriot et al[19] have defined the ECG criteria for a proximal RCA occlusion as ST elevation in V1 or ST depression in V1<0.5mm showing discordancy with V2. So, we proceeded to analyze this criterion in our study. We found that this criterion had a sensitivity, specificity, positive predictive value, negative predictive value of 82.8%, 74.3%, 72.7% and 83.9% with the p value (<0.001) being statistically significant.

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Left circumflex occlusion:

According to a study by Fiol et al[14], LCx lesions can be diagnosed using the ECG criteria of ST elevation in lead II more than ST elevation in lead III, ST elevation in I and aVL and by the ratio of sum of ST depression in V1-V3 to the sum of ST elevation in II, III and aVF more than 1.

On applying the above 3 criteria in our study, we found that for the ECG criteria ST elevation in II more than III, the sensitivity, specificity, positive predictive value, negative predictive value was 66%, 100%, 100% and 92.9% respectively. Our result was similar to the one obtained by Jim et al[20] who found the sensitivity and specificity to be 57% and 100% respectively for this criterion.

The ECG criteria ST elevation in leads I and aVL had 50%, 100%, 100% and 89.7% sensitivity, specificity, positive predictive value, negative predictive value respectively. In the study done by Nair et al[18] the sensitivity and specificity for the criteria ST elevation in lead 1 was 60% and 100% respectively which is very similar to our results.

The sensitivity, specificity, positive predictive value, negative predictive value for the ECG criteria, ratio of sum of ST depression in V1-V3 to the sum of ST elevation in II, III and aVF more than 1 were found to be 66.7%, 100%, 100% and 92.7% respectively. In the study by Drew et al[21] they found the sensitivity and specificity to be 84% and 95% respectively. The p value was <0.001 for all three criteria in our study.

Our study showed that for IWMI, the overall sensitivity of ECG criteria for diagnosing LCx occlusion is lesser than that of RCA while the specificity is more for LCx than for RCA.

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Conclusion

- From the above-mentioned results, we concluded that ECG is crucial, reliable and very useful for predicting the occluded level in the coronary artery to a statistically significant level when compared to coronary angiographic results.
- The admission ECG is important for determining early reperfusion therapy and also for providing information regarding the location and extent of acute myocardial injury in patients with STEMI

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