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DIAGNOSTIC ACCURACY OF ELECTROCARDIOGRAM IN DETECTING THE CULPRIT CORONARY IN ACUTE ST ELEVATED MYOCARDIAL INFARCTION

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Abstract:
Objective: To determine diagnostic accuracy of electrocardiogram (ECG) in detecting the culprit coronary in acute ST elevated myocardial infarction (STEMI).

Introduction: Cardiovascular diseases (CVDs), especially coronary heart disease (CHD), have assumed epidemic proportions worldwide. In making the clinical decision for the early management in patients with acute myocardial infarction specific indicator is needed. Ideally, this indicator should be simple, quick, reliable, noninvasive, inexpensive, and easily applicable to all the patients. Coronary Angiography which is the gold standard to detect the culprit vessel invasive, expensive, requires skilled personnel, is time consuming and involves radiation exposure.This study will depict the importance of knowing culprit artery responsible for STEMI before putting the patient to invasive coronary angiography and in some cases; it can categorize the group patients who are at higher risk of considerable damage to the myocardium.Only few studies have examined the predictive utility of ECG in predicting the culprit vessel hence this study was carried out to find out the diagnostic accuracy of ECG in comparison to coronary angiography in predicting the culprit coronary in acute STEMI in resources limited setting of rural central India.

Materials and Methods: This was a hospital basedcrossectional study which was conducted in rural hospital of central India from October 2016 to May 2018, included 168 patients of acute ST elevated myocardial infarction who underwent coronary angiography (CAG). Standard ECG criterias for localization of culprit vessel occlusion site were specified and the culprit coronary was predicted on admission electrocardiogram. Subsequently the study subjects were subjected to coronary angiography and the results of coronary angiography were compared with those predicted by electrocardiogram. Correlation between ECG and CAG was done using Cohen's- Kappa statistical analysis method.
Results: The sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV) of ECG for detecting LAD as a culprit artery were 94.1%, 96.4%, 96.3% and 94.2% respectively. Diagnostic accuracy of ECG to detect LAD as culprit artery was 95.2% while it was 79.2% for RCA and 84.2% for LCx. The sensitivity, specificity, PPV and NPV for detecting RCA as a culprit coronary was 80%, 74.3%, 61.9% and 84.2% respectively. The ECG has 84.2% sensitivity and 57.8% specificity, 61.9%PPV and 84.2% NPV for predicting LCx as a culprit

artery.Majority of study subjects 85 (50%) had single vessel disease, 34 (20.2%) had double vessel disease and 24 (14.3%) had triple vessel disease while 25 patients had normal coronaries/ insignificant CAD.
Conclusion:ECG information can be readily used to predict the culprit coronary in acute ST elevated myocardial infarction inresource poor setting areas for coronary angiography, it can also tell the complications in patients of acute MI before thrombolysis, if RCA is predicted to be involved.
Keywords:12 lead-ECG, Acute ST elevated Myocardial Infarction, Culprit artery, Coronary Angiography, Right Coronary artery, Left anterior descending, Left Circumflex

INTRODUCTION:

Cardiovascular diseases (CVDs), especially coronary heart disease (CHD), have assumed epidemic proportions worldwide and is the leading cause of morbidity and mortality globally.(1)An estimated 17.9 million people died from CVDs in 2016, representing 31% of all global deaths.(2)

In India, more than 10.5 million deaths occur annually, and it was reported that CVD led to 20.3% of these deaths in men and 16.9% of all deaths in women.(3)

In making the clinical decision for the early management in patients with acute myocardial infarction specific indicator is needed. Ideally, this indicator should be simple, quick, reliable, noninvasive, inexpensive, and easily applicable to all the patients.(4) Coronary Angiography which is the gold standard to detect the culprit vessel and to know the degree of blockage is invasive, expensive, requires skilled personnel, is time consuming and involves radiation exposure. Coronary angiography is most specific to determine the Ischemia related artery (IRA).(5)

Knowing area of ischaemic myocardium, its size and location determine aggressiveness of therapy and help in selecting patients most likely to profit from thrombolytic therapy.

This study will depict the importance of knowing culprit artery responsible for STEMI before putting the patient to invasive coronary angiography and in some cases; it can categorize the group patients who are at higher risk of considerable damage to the myocardium. Not all hospitals in this country and more so in rural areas, have adequate facilities to perform urgent coronary angiography. In making the clinical decision for the early management in patients with acute myocardial infarction, an early and specific prognostic indicator is needed. In this aspect, an assessment by the universally available Electrocardiogram (ECG) may meet all these requirements if certain calculation criteria's were applied.(6) Only few studies have examined the predictive utility of ECG in predicting the culprit vessel hence this study was carried out to find out the diagnostic accuracy of ECG in comparison to coronary angiography in predicting the culprit coronary in acute STEMI in resources limited setting of rural central India.

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MATERIALS AND METHODS:

Study design and Study setting: This was a cross sectional diagnostic accuracy study which was carried out in Intensive Coronary Care Unit of the Department of Medicine of a rural based teaching hospital. The patient population was largely rural, with semi-urban and urban patients also presenting to the hospital. Approval from the institutional ethics committee was sort before beginning the study.

Study period: The study duration was from the October 2016 to March 2018

Study population: All consecutive patients of ST elevated acute myocardial infarction who underwent Coronary Angiography between October 2016 to March 2018 were included in the study. Acute ST elevated myocardial infarction was defined as chest pain of >30 minutes duration and persistent ST-segment elevation of more than 2mm in two or more anterior or more than 1 mm in two or more inferior leads on admission.

All patients enrolled in the study were briefed about the nature of the study and informed consent in the local language was taken from them.

Inclusion Criteria:

Patients of ST elevated acute myocardial infarction (STEMI) who underwent Coronary angiography (CAG) between October 2016 to March 2018 were included in the study.

Exclusion Criteria:

1. Patients who had previous MI (Myocardial Infarction)
2. Patients with previous CABG (Coronary Artery Bypass Grafting)
3. Patients who were not willing to participate in the study.

Sample size

Sample size : The sample size for this cross sectional study was calculated by the statistical formula given below. (7)

Sample size = Z 1-α 2 x p (1-p)/ d2

Z 1-α is standard normal variate. The calculated sample size was 168 patients of Acute STEMI who underwent coronary angiography.

Sampling method:

We screened 363 consecutive patients of Myocardial Infarction over a period of 18 months from 1st October 2016 to 31st march 2018. We included 168 study subjects based on the inclusion and exclusion criteria.

Methodology:

This study was divided in the following parts.

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1. **Study subjects enrolment**:
After taking valid informed consent, complete history and clinical examination was done for the study subjects.

2. Study questionnaire and proforma:

All study subjects presenting with complains of chest pain and or breathlessness and or palpitation underwent complete clinical examination followed by ECG to identify STEMI, those willing for participating in the study were asked for the relevant history and symptoms. All the relevant findings of included study subjects were noted in the proforma.

a. Clinical examination: The study subjects were examined thoroughly for the symptoms and signs of Myocardial Infarction and cardiac failure (like chest pain, breathlessness, palpitation, swelling of legs, temperature, pulse, respiratory rate, pallor, raised jugular venous pressure, pedal edema, etc). Blood pressure was measured in supine position with cuff tied in arm. Blood pressure was graded as per classification proposed by JNC 8 criteria

b. Haematological Workup- Haemoglobin estimation was done by automated coulter in central laboratory of the hospital inall 168 study subjects at admission and data was obtained

c. Following Biochemical workup was done: Cardiac biomarker Troponin T Random blood sugar Lipid profile constituting fasting sample of serum cholesterol, High density lipoprotein, Low density lipoprotein, Triglycerides and Very low density lipoprotein was obtained and analyzed.

3. Measurements:

The recruited study subjects were then subjected to index test i.e. electrocardiography to predict culprit coronary artery after that underwent gold standard test i.e. coronary angiography for confirmation of culprit coronary. Coronary angiographies were performed by Cardiologist with experience of more than 15 years. Principal investigator was blind for the results of coronary angiography.

Interpretation of ECG: Each ECG was reported by a principal investigator. The findings were recorded with respect to rate, rhythm, axis and ST segment morphology. The ECG findings recorded were classified with respect to rate (Sinus tachycardia/bradycardia), rhythm (left or right bundle branch blocks, ventricular premature contractions, premature atrial contractions), morphology (left/right ventricular hypertrophy, left atrial/biatrial enlargement), ST segment shifts: STEMI,NSTEMI.

a) Prediction of culprit coronary artery:

- **ECG Criteria to Identify Site of Occlusion in LAD:** The culprit coronary artery was predicted using the standard ECGcriterias as follows
- **ECG Criteria to Identify Site of Occlusion in LAD (in Anterior Wall MI)**

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CRITERIA	OCCLUSION SITE
1. Any one or more of the following i. Complete RBBB ii. ST ↑ V1 > 2.5 mm iii. ST ↑ aVR iv. ST ↓ V5 v. New onset LAHB	Proximal to S1
2. Q in aVL	Proximal to D1
3. Any one or more of the following i. ST ↓ II ≥ 1.0 mm i. Maximum ST ↑ appeared in V2	Proximal to S1 and/or D1
4. Q in V5	Distal to S1
5. ST ↓ aVL	Distal to D1
6. No ST ↓ III	Distal to S1 and/or D1

- **ECG Criteria for Site of Occlusion in RCA:**

Criteria	Proximal to RV branch	Distal to RV branch
V4R	ST ↑ ≥1 mm	No ST ↑
ST ↑ V1	Present	Absent
ST ↑ VR > ST ↑ in V1-V3	Present	Absent
Ratio of ST ↓ V3/ST ↑ III	< 0.5	>0.5, but <1.2
AV nodal block	Present	Absent
Atrial infarction	Present	Absent

- **ECG Criteria to identify whether site of occlusion is in RCA or LCx:**

Criteria	RCA	LCx
***1. ST ↑ III > ST ↑ II**	Present	Absent
***2. ST ↓ aVL> ST ↓ I**	Present	Absent
***3. ST ↓ V3/ST ↑ III ratio**	<1.2	>1.2
4. Lead V4R	T-wave upright	Inverted T-wave
5. ST ↓ V1-V2	Absent (present in occlusion of dominant RCA causing posterior wall MI)	Present
6. Max ST ↓ V2-V3	Absent	Present
7. ST ↑ V7-V9	Absent (present if RCA dominant)	Present

*In case of discrepancy between criteria 1, 2 and 3, the localization was done as per criteria 1 and 2 rather than 3. Criteria 5 to 7 were used mainly for supportive evidence.

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Coronary Angiography (Gold Standard): All study subjects were subjected to coronary angiography. Coronary angiographies were performed and evaluated by Cardiologist with experience of more than 15 years.

a) **Interpretation of coronary angiographies:**Normal or insignificant stenosis:< 25%, low grade: 25-49%, intermediate grade: 50-74%,high grade: 75-90%, subtotal: 91-99 %, total occlusion 100% stenosis.

Operational definitions:

1. **Acute ST elevated Myocardial Infarction**: Chest pain of >30 minutes duration and persistent ST-segment elevation of more than 2mm in two or more anterior or more than 1 mm in two or more inferior leads on admission.
2. **Significant lesion/stenosis:** It defined in the coronary angiogram by the presence of total occlusion, >70% stenosis, acute thrombosis or dissected plaque in the coronary artery.

   Insignificant coronary artery disease (Normal): It defined in the coronary angiogram by the presence of minimal occlusion, <25% stenosis, partial thrombosis in the coronary artery.

Single Vessel Disease (SVD): One-vessel coronary artery disease was defined as 75% or greater stenosis in a major coronary vessel: LAD or large diagonal branch; left circumflex (LCA), large optional diagonal, or large marginal branch; and right coronary artery (RCA).

Proximal LAD was defined as the part of the anterior descending artery proximal to and/or including the origin of first septal perforator

Mid LAD defined as the part distal to the first septal perforator up to second diagonal branch

Distal LAD after the origin of second diagonal branch. (8)

Double Vessel Disease (DVD): There was greater than or equal to 50% stenosis (reduction in cross-sectional area) in two coronary arteries (or greater than or equal to 50% stenosis in the left main coronary artery).

Triple Vessel Disease (TVD): There was greater than or equal to 50% stenosis (reduction in cross-sectional area) in three coronary arteries.

STATISTICAL ANALYSIS: Statistical analysis was done by using descriptive and inferential statistics using chi-square test, sensitivity, specificity, Positive predictive value, negative predictive value and diagnostic accuracy.

Correlation between ECG and CAG was done using Cohen's- Kappa statistical analysis. Interpretation of Kappa.

- < 0 - No Agreement
- 0–0.20 Slight,
- 0.21–0.40 Fair,
- 0.41–0.60 Moderate,

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- 0.61–0.80 Substantial,
- 0.81–1 Almost Perfect Agreement.

Softwares used in the analysis were SPSS 22.0 version and Graph Pad Prism 6.0 version. $p<0.05$ is considered as level of significance.

RESULTS:

A total of 168 acute STEMI patients who underwent CAG were included in this study.Majority of study subjects (59%) belonged to 45-54 years age group.In our study the mean age of presentation was 54.7 years, in men it was 54.4years and in women it was 55.5 years. Males formed 66.7% of the study and females constituted 33.3% of the study. The youngest age at presentation was 25 years and the maximum age at presentation was found to be 81 years. The most common presenting symptom was chest pain 61.4. % study subjects presented with chest pain <3 hours second most common complaint was breathlessness followed by palpitation.

Distribution of patients according to chest pain (N=168)

Chest Pain	No of patients	Percentage (%)
≤3 hours	98	61.4
>3 hours	59	38.6
Total	168	100.00

Findings on general examination (pulse rate, temperature and respiratory rate) were as follows: Tachycardia was found in14.8%, bradycardia in 7%, tachypnoea in 41.6% and increased temperature in 4.8% of the study subjects. Majority of study subjects (41.1%) were in stage I hypertension while 31.5% had prehypertension as per systolic BP however 39.3% were in stage I hypertension and 29.2% had prehypertension according to diastolic BP.

In our study 38.7% subjects were hypertensive, diabetes was found associated with 42.8% study subjects. In our study out of 168 patients, 20.8% patients were smokers and dyslipidaemia was found in 21.2% study subjects **Distribution of patients according to risk factors (N=168)**

Risk Factors	No. of patients	Percentage (%)
Diabetes Mellitus	72	42.8
Hypertension	65	38.7
Smoking	35	20.8
Dyslipidemia	13	7.7
Obesity	21	12.5

Troponin T levels were raised in 136 (80.9%) study subjects and it was normal in 32 (19.1%) study subjects. Out of 168 study subjects cholesterol was raised in 30 (17.9%), triglycerides was raised in 91 (54.2%), LDL was raised in 44 (26.2%) and

VLDL was raised in 35(20.8%) of the study subjects. HDL level was normal in 128 (76.2%) and decreased in 40 (23.8%) study subjects. Mean cholesterol level was 163.54±37.41.Chest X-ray showed that 12 study subjects (7.1%) had cardiomegaly.

Electrocardiographic analysis for culprit artery in STEMI patients

Among 168 study subjects with STEMI as predicted by ECG, majority 84 (50%) had involvement of LAD. RCA involvement was found in 45 (26%) while LCx involvement was found in 39 study subjects (23.2%).

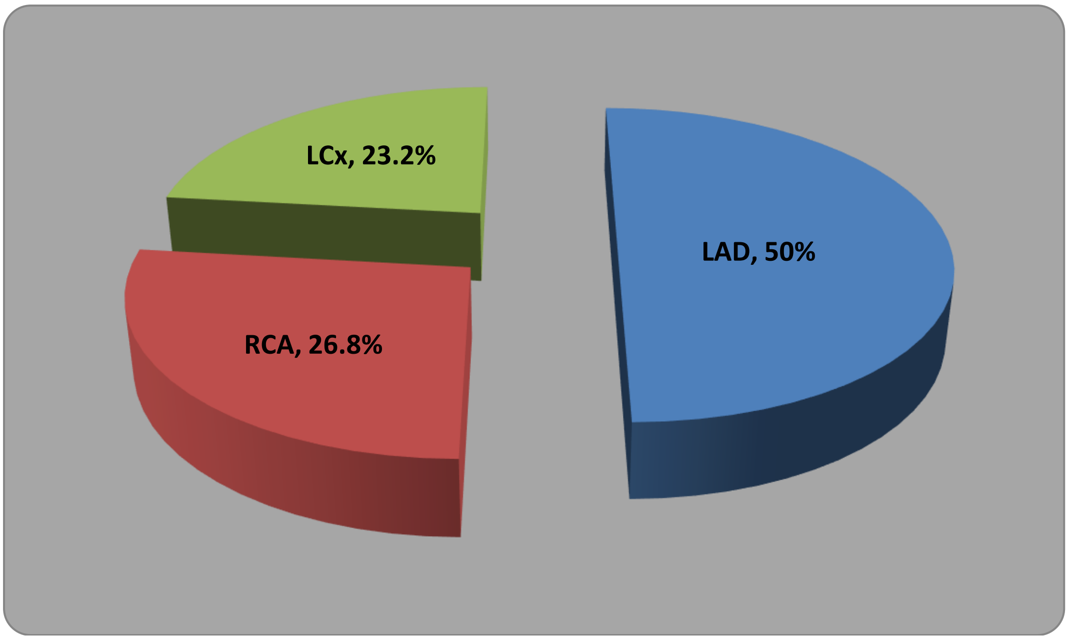

Figure 1: Electrocardiographic profile of study subjects

Angiographic profile of the study subjects: Majority of study subjects 85 (50%) had single vessel disease, 34 (20.2%) had double vessel disease and 24 (14.3%) had triple vessel disease while 25 patients had normal coronaries/ insignificant CAD.

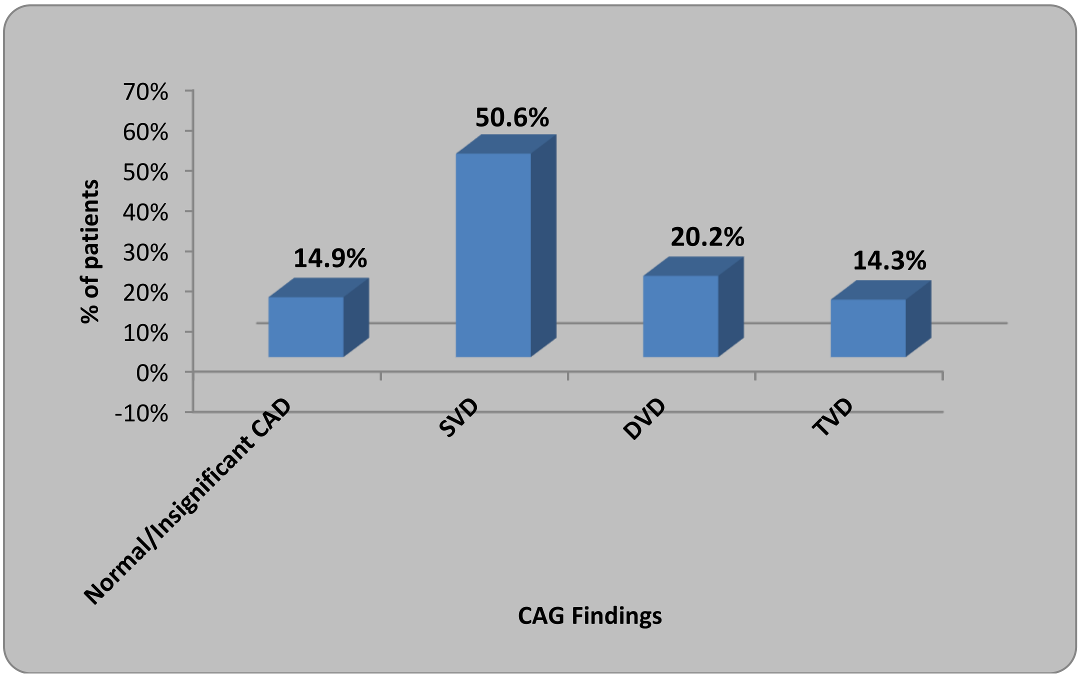

Figure 2: Distribution of study subjects according to CAG findings

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In our study high sensitivity (94.1%) along with high specificity 96.4% for LAD occlusion in was found on ECG. The positive predictive value (PPV) 96.3% and negative predictive value (NPV) were 94.2% and diagnostic accuracy of ECG to detect LAD as culprit artery was 95.2%.

1. Out of 168 study subjects 45 (26.8%) had lesion proximal to both D1 and S1. Twelve (7.1%) study subjects had lesion proximal to S1 but distal to D1. Eighteen (10.7%) study subjects had lesion distal to S1 and proximal to D1 and 9 (5.4%) study subjects had lesion distal to both D1 and S1 in anterior wall MI cases.

2. Diagnostic accuracy of ECG for detecting the lesion proximal to D1 is 89.3% the sensitivity is 90%, specificity is 88.2%.The PPV is 91.8% and NPV was 85.7%.
3. -Diagnostic accuracy of ECG for detecting the lesion distal to D1 73.8%, sensitivity 71.1%, specificity 76.9%, PPV 78.1% and NPV was 69.7%.
4. Diagnostic accuracy of ECG for detecting the lesion proximal to S1 is 79.8% sensitivity of ECG was 93.8%, specificity was 52%, PPV 63.1% and NPV was 89.7%.
5. Diagnostic accuracy of ECG for detecting the lesion distal to S1 62.5%, the sensitivity 40% and specificity was 90.91%, The PPV 90% and NPV 89.7%,
6. Diagnostic accuracy of ECG for detecting RCA occlusion is 79.2%.it has 80% sensitivity and 74.3% specificity for detecting RCA occlusion. The PPV and NPV are 92.2% and 50% respectively
7. Diagnostic accuracy of ECG for detecting LCx occlusion is 84.2%, it has 57.8% sensitivity and 86.9% specificity for detecting LCx occlusion. The PPV and NPV were 61.9% and 84.2%. respectively
8. In the present study Cohen's Kappa statistics was used to see correlation between electrocardiogram and coronary angiography for predicting culprit coronary artery. Cohen's Kappa statistics for lesion in LAD (k=0.926), proximal to D1 (k=0.975), proximal to S1 (k=0.904) and for lesion in LCx (k=0.953) shows almost perfect agreement i.e. between 0.81-1. However Cohen's Kappa statistics for lesion in Proximal to S1 (k=0.778) Distal to S1 (k=0.618) and in RCA (k=0.739) shows substantial agreement between 0.61-0.80.

Discussion:

Acute myocardial infarction is a common disease with serious consequences, with high mortality, morbidity and cost to the society.(9) In anterior wall myocardial infarction (AWMI), the occlusion is nearly always in the left anterior descending (LAD) coronary artery, with inferior wall myocardial infarction (IWMI) either the RCA or the left circumflex (LCx) coronary artery may contain the culprit lesion.(10) RCA occlusion has a higher risk of poor outcomes due to involvement of right ventricle.(11, 12). Pre hospital 12- lead electrocardiogram (ECG) has been used to reduce the time interval between first medical contact and treatment times.(13) In ST elevation MI, identifying the culprit artery on presenting ECG can lead to earlier risk stratification and better guide therapy for reperfusion (14). Electrocardiogram is being used as reliable and inexpensive tool to diagnose acute myocardial infarction (AMI) in the patient with chest pain. An emphasis has been made on ECG features that allow better identification of the coronary occlusion site and thereby better estimation of the size of the area at risk, which is important for the preferred type of reperfusion. The

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closer the occlusion site to the origin of the coronary artery the larger the ischemic area and the greater the necessity of a rapid reperfusion attempt.(15)

Various ECG criterias have been suggested to predict the culprit artery in acute ST elevated myocardial infarction (STEMI) based on analysis of ST elevation in different leads. Various authors like Ghosh et al.(16), Fiol et al.(17), Engelen et al.(18) , Herz et al.(19) , Vasudevan et al (20) Tamura et al.(21) Karha et al.(22)Yotsukura et al.(23)wellens et al(18) Birnbaum et al.(24)Zimetbaum et al.(25) Kim KY et al.(26) used different criterias to predict culprit artery. In the present study we studied previously published criterias for detecting the culprit coronary and combined those criterias and used them to assess the validity of these criterias by statistical analysis using Cohen's kappa statistical method and found correlation of ECG with coronary angiography (CAG) in the form of diagnostic accuracy of ECG in detecting the culprit coronaries.

The diagnostic accuracy of LAD, RCA and LCx in our study was 95.2%,79.2% and 84.2% respectively.

Similar results were noted by Khan et al.(27)and Ghosh et al.(16) Mean age of patients was 53.21± 9.58 years similar to the study by Ghosh et al and Chakraborty et alWhereas, Almansori et al (28)in their study had 76 % male patients with IWMI with mean age of 59.7±11.7 years.

Waduud et alin a retrospective study involved 379 patients from two different hospital settings in United States, in both group males outnumbered females,133 males and 50 female in first setting and 136 male and 60 females in second setting. Over all mean age in their study was 60.5 years.(29).

In our study 38.7% patients were hypertensive which was similar to the results by Ghosh et al (16)Almansori et al. (30)and Sedik et al. respectively(28). However Sanani et al(31) in their study had 64.9 % patients with hypertension and 75.5% patients had hypertension in study by Khan et al.(27) this difference may be due to the dfference in the ethnicity and age group of the population.

Coronary angiogram analysis in the present study revealed the presence of SVD in 50.6% of the patients, 20.2% of the patients had DVD and 14.3% of the patients had TVD. And remaining 14.9 % had insignificant CAG finding. Ghosh et al in their study had 61.90% patients with SVD,19.05% patients had DVD and 19.05% patients had TVD. Angiographic data in study by Sedik et al(28) showed 79% patient with RCA as culprit vessel,20% patient with LCX as culprit,67% with RCA dominance,33% patient with LCX co dominance,25% with multi-vessel disease and 1% unidentified.

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In present study out of the 168 STEMI patients enrolled, all underwent ECG followed by CAG, Out of which 84 (50%) study subjects were predicted to have LAD occlusion, 45 (26.79%) had RCA occlusion,39 (23.21%)study subjects had LCx occlusion. On CAG findings Single vessel disease(SVD) was present in 85 (34%) study subjects, Double vessel disease (DVD) was present in 34 (20.2%) study subjects., Triple vessel disease (TVD) was present in 24 (14.3) study subjects and insignificant CAD or normal or recanalised coronaries were present in 25 (14%) study subjects. In the present study findings the ECG had high diagnostic accuracy for LAD, the sensitivity ,specificity, PPV, NPV and diagnostic accuracy of LAD was 94.05%, 96.43%, 96.34%, 94.19%and 95.25% which was comparable to the results obtained by Ghosh et al, Engelen et al. Among the branches of LAD the diagnostic accuracy and sensitivity was maximum for LAD proximal to D1 90% and 88.28% respectively which was comparable to the findings of Ghosh et al.(16) and Engelen et al.(18) The specificity was maximum 90.91% for the lesion distal to S1 similar to the findings of Ghosh et al.(16) Sensitivity and PPV for lesion proximal to D1 was 90% and 91.84% in our study while it was in study by Ghosh et al(16) sensitivity and PPA was 0.00%. which could explained by the small sample size in their study (n=21).

In our study sensitivity of ECG for detecting RCA was 80.45% , specificity was 74.29 which was comparable to the study by Herz et al, Kosuge et al.(14), Ghosh et al.(16), Bairey et al.(32) PPA and NPA in present study for RCA was 92.24% and 50% respectively. Similar results were noted in the study by Bairey et al. (32)

Present study found that the Sensitivity and specificity for detecting LCx as a culprit coronary artery was 57.78% and 86.99% respectively which was comparable to study by Fiol et al. The PPV and NPV in present study was 61.90 and 84.92 respectively which was comparable to the study by Fiol et al.

In study done by Chakraborty et al (8) after analyzing the data with Cohen’s kappa they found moderate agreement between ECG and CAG for LAD in AWMI where as it was fair agreement for lesion distal and proximal to D1. For lesion Distal and proximal to S1 there was substantial agreement. Excellent agreement was obtained for lesion in RCA and LCx in IWMI. While in present study we obtained almost perfect agreement in LAD and all lesions proximal and distal to D1, substantial agreement was obtained in lesion proximal and distal to S1. In cases with IWMI LCx occlusion showed almost perfect agreement while RCA had substantial agreement.

In anterior wall myocardial infarction to detect LAD as a culprit artery Ghosh et al used similar criterias as in the present study and found ECG to have the sensitivity of 100% specificity of 92.9% to detect LAD as a culprit coronary and the PPA and NPA was 90.9% and 100% respectively. While the sensitivity and specificity for detecting the branches of LAD was 42.9 and 92.9%, Distal to S1 but proximal to D1 0% and 90%, Distal to both S1 and D1 100% and 77.78% and distal to S1 were 50% and 78.95% respectively. The positive predictivde accuracy (PPA) and negative predictive accuracy (NPA) for these branches Proximal to S1 and D1, Distal to S1 but proximal to D1, Distal to both S1 and D1, distal to S1 were (75% and 76.47%), (0% and 94.74%), (20% and 93.75%) (42.86% and 100%) respectively. For RCA and LCx the sensitivity

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and specificity was of RCA was Sensitivity 100% and specificity 91.67% for LCxSensitivity 0% and specificity 100% The PPA and NPA for RCA and LCx coronary arteries were 90% and 100%, undetermined and 90.5%, respectively. The study had small sample size N=21

Engelen et al (18) in the study of patients with acute AWMI showed that for different ECG criteria used in our study to localize LAD proximal to S1 and/or D1 the Sensitivity, specificity, PPA and NPA varied from 12% to 44%, 80 to 100%, 67 to 100% and 61 to 70%, respectively. Similar figures for ECG criteria to localize occlusion in LAD distal to S1 and/or D1 were 22-41%, 86-95%, 77-92% and 46-53%, respectively.

Richard et al.(33) in their study to detect culprit coronary lesion in prehospital 12 lead ECG in 181 study subjects found that, Sensitivity, specificity, PPV was 50,100 and 100 % respectively for proximal LAD lesion location; 90%,100% and 100% for all LAD lesions, 98%, 72% and 78% for RCA; and 50%,98% and 90% for LCx. specificity and PPV were high for proximal LAD, LAD and LCx. specificity and PPV are not as high for RCA.

In study by Herz et al(19) in patients with IWMI the Sensitivity to localize RCA occlusion varied from 55% to 95%, the specificity,PPV,NPV varied from 71% to 100%, 88% to 100% and 29% to 75% respectively. The Sensitivity, specificity, PPA and NPA for LCx were 88%, 100%,100% and 97% respectively. (19)

Another study to determine IRA in acute IWMI study for RCA and LCx culprit artery by Sadik et al (28) In Group I, the ST segment elevation in lead III greater than lead II and ST segment depression in lead I > 0.05 mm had a comparable sensitivity (78% and 71% respectively) and specificity (60%. and 65% respectively) for RCA as the culprit artery. The ST segment elevation ≥ 1mm in V4R had very low sensitivity (37%) and highest specificity (100%). In Group II, ST segment depression ≥ 1mm in aVR was the best criteria for LCX as the culprit artery with sensitivity of 60% and specificity 81%. The sum of ST segment elevation in lead II, III and aVF was higher in proximal RCA (8.51±4.44mm) than both mid RCA (5.95 ± 3.06 mm) and distal RCA (5.00 ± 2.77 mm) (P value <0.001). The study concluded that it is possible to predict the culprit coronary artery in acute inferior wall MI by using the readily obtainable measures on the admission ECG.

Kosuge et al(14) studied the criteria of ratio of ST ↓ V3/ST ↑ III in patients with acute IWMI and found the sensitivity, specificity, PPA and NPA for RCA occlusion proximal to RV branch to be 91%, 91%, 88% and 93%, respectively. The similar figures for RCA occlusion distal to RV branch were 84%, 93%, 91% and 88% and those for LCx coronary artery occlusion were 84%, 95%, 73% and 98%, respectively.(14)

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The following tables give comprehensive data about various studies and its diagnostic accuracy in comparison with the present study.(18)

Table No 3: Diagnostic accuracy of ECG to Identify Site of Occlusion in LAD (in AWMI): comparison of present study with different studies (34)

Studies Done	Vessel predicted IRA	Sensitivity%	Specificity%	PPV%	NPV%	Diagnostic accuracy %
Present study 2018	LAD proximal to S1	93.2	52.0	63.1	89.7	79.8
	LAD Distal to S1	40	90.91	80	62.5	66.67
	LAD Proximal to D1	90	88.24	91.84	85.71	89.28
	LAD Distal to D1	71.11	76.92	78.05	69.77	73.80
	LAD	94.05	96.43	96.34	94.19	95.23
Ghosh et al(41)	LAD	100	90.91	90.91	100	
Waddud et al(59)	LAD	74.1	96.1	92.4	85.4	
Khan et al(53)	LAD proximal to D1	91	70.45	91.61	68.88	86.50
Engelene et al(34)	Proximal to S1 & /D1 Distal to D1 and S1	12-44% 22-41%	85-100% 86-95%	67-100% 77-92%	61-70% 46-53%	- -
Chakraborty et al.(56)	Proximal to D1	29	86	83	33	-
	Distal to D1	62	69	45	82	-
	Proximal to S1	90	33	73	61.5	-
	Distal to S1	33	90	61.5	73	-

Table 2: Diagnostic Accuracy of Different ECG Criterias in IWMI in Different Studies

Studies	ECG criteria	Study Type	Infarct related artery	Sensitivity	Specificity	PPA	NPA
Present study 2018	Standard ECG criterias	Crosssectional study	RCA LCx	80.4 57.8	74.3 86.9	92.2 61.9	50 84.9
Ghosh et al(41)(2013)	Various criteria	Crosssectional study	RCA LCx	100 0	91.67 100	90 undetermined	100 90.5
Waddud et al(59)(2011)	3 step algorithm of Fiol et al	Crosssectional study	RCA LCx	74.1 35.5	90.9 94.8%	86.9 37.9	81.2 94.3
Herz et al(74) (1997)	Various criteria	Crosssectional study	RCA LCx	55-94 88	71-100 100	88-100 100	29-75 97
Kosuge et al (68) (1998)	Ratio of ST ↓ V3/ST ↑ III	Cross-sectional study	RCA proximal to RV branch (<0.5) RCA distal to RV branch (>0.5, <1.2)	91 84	93 93	91 91	98 88
Verouden et al (83)(2009)	ST ↑ III >II, ST↓I or aVL>1 mm Above + ST deviation >18.5 mm	Cross-sectional	RCA RCA	70 90	72 -	- -	- -
Zimetbaum et al (30) (2003)	ST ↑ in III>II and I and/or aVL<-1 mm	Cross-sectional study	RCA	70	72	90	39
Chia B-L et al (84) (2000)	ST ↑ in III>II and any ST↓ in I	Cross-sectional	RCA	76	66	89	42
Bairey C N et al(82) (1987)	ST ↓ in I ST ↓ in aVL	Cross-sectional study	RCA RCA	79 95	61 24	89 82	44 56
Fiol et al(73) (2009)	ST ↑ III > ST ↑ II ST↓ in I	Cross-sectional	RCA RCA	99 92	100 77	- -	- -
Sedik et	ST ↑ in III>II	Retrospecti	RCA	78	71	-	-

al(55)(2017)	ST ↓≥1mm in aVR	ve cross sectional	LCX	60	81	-	-
Chakraborty et al(56)(2017)	Various criteria	Crossectional study	RCA LCx	100 33.3	33.3 100	92.30 100	100 92.3

IRA: Infarct related artery; IWMI: Inferior wall myocardial infarction; NPA: Negative predictive accuracy; PPA: Positive predictive accuracy, ST↑: ST-segment elevation; ST↓: ST-segment depression.

in patients with acute MI results in lower quality care in emergency room and highlights the importance of system changes to enhance the accuracy of ECG interpretation (37)

Although coronary angiography is the gold standard for determining the infarct-related artery in acute myocardial infarction, the ECG can be a clinically valuable tool in identifying the culprit artery [8].

Knowing that the occlusion is proximal or distal to D1 or S1 may be crucial for deciding on the best approach to treatment: to start fibrinolytic treatment and keep the patient in the hospital because the risk of a large AMI is low, or, independently of fibrinolytic treatment, make the decision to send the patient immediately to a referral center for a PCI, since there is ECG evidence that the risk of a large AMI is high. Furthermore , if we have the evidence that a major left ventricular area is involved and there is a danger of MI, we may prefer to administer Fibrinolytic treatment in the first hour in the emergency room or in an ambulance than perform PCI . Occlusion of the LAD artery may lead to a very extensive anterior MI, or only septal, apical-anterior or mid-anterior according to the site of occlusion.(38) Proximal LAD occlusion has been documented as an independent predictor of poor outcome related to higher mortality and recurrent MI and distal LAD occlusion is considered to have a better outcome. (22)

Mortality and morbidity in part are determined by the location of the occlusion. For example, in patients with inferior MI who have RV infarction, the culprit artery virtually always is the RCA. Such patients, including those in whom ECG evidence of RV MI is masked, are at increased risk for death, shock and arrhythmias, including atrioventricular block. Thus, identifying the culprit artery in acute IWMI help define those in whom aggressive reperfusion strategies are likely to yield most benefit. Coronary arteriography is the best means of determining the culprit artery in acute IWMI. When both the RCA and LCx are severely diseased and patient is seriously ill where CAG is not possible, deciding which one is the culprit can be difficult and having an independent predictor of the culprit artery, such as the ECG, can be very helpful.

- Strength:The major strength of our study is use of standardised protocol and an adequate sample size. Our study had a larger sample size compared to some ofthe previous studies undertaken
- Our study has considered all the three coronaries at a time previous studies have either considered RCA-LCx territory of inferior wall MI or LAD territory of anterior wall MI.

Limitations:

- In some study subjects coronary angiography was done after thrombolysis with STK so if the culprit coronary was successfully thrombolysed the findings of electrocardiogram predicted artery did not match with the angiography findings which showed normal coronary or insignificant disease or recanalised vessel.
- It was a single hospital based study and there may be diagnostic variabilities among different hospitals, because of its crossectionalnature temporal associations could not be studied. Since the study was hospital based it may have omitted a certain spectrum of disease limiting its generalization.
- Lastly this study was done on Indian population , so the results may not be applicable to other populations of different ethnicity.

Future perspective of the study

Electocardiogram can be used to detect the culprit coronary in the settings of automated prehospital 12 lead ECG machine so that the paramedics can identify the number of coronaries involved and appropriety refer the patient to PCI capable /incapable centres and reduce the time required for the triage of patients with STEMI and the duration of their appropriate treatment hence it will help the physician reduced the door to needle time. A study with larger sample size including patients from different areas with varying STEMI burden could help achieve a more accurate results. Also further evaluation of diagnostic algorithms in different epidemiological and geographical settings and patient populations can be undertaken.

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