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A Prospective Study on Predicting the Culprit Artery from Electrocardiogram in Acute St-Elevation Myocardial Infarction (STEMI) and Correlation with Coronary Angiographic Findings

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Abstract: ***Background: Acute ST-elevation myocardial infarction (STEMI) is one of the most critical manifestations of coronary artery disease and remains a leading cause of mortality worldwide. Rapid identification of the culprit artery before coronary angiography can significantly influence treatment strategy and improve clinical outcomes. Electrocardiography (ECG) remains the fastest and most accessible diagnostic tool in acute STEMI and may provide valuable clues regarding culprit vessel localization. Materials and Methods: This prospective observational study included 100 patients diagnosed with acute STEMI admitted in the Department of Cardiology, MGM Medical College and Hospital. Detailed clinical examination, risk factor assessment, ECG analysis, and coronary angiography were performed. Patients were categorized into AWMI and IWMI groups. Various ECG markers were studied and correlated with culprit artery localization. Results: The majority of patients were male (74%), and the most affected age group was 41–60 years (52%). Hypertension (54%) and diabetes mellitus (46%) were the predominant co-morbidities. AWMI constituted 68% and IWMI constituted 32% of total cases. In AWMI, ST elevation in V1 >2.5 mm, complete RBBB, and ST elevation in aVR strongly predicted proximal LAD occlusion. In IWMI, ST elevation in V4R >1 mm and ST elevation in V1 significantly correlated with proximal RCA occlusion. Coronary angiography confirmed LAD as the most common culprit vessel. Conclusion: ECG remains a simple, rapid, and highly useful bedside modality for early prediction of culprit artery in STEMI and can assist in early intervention planning.***

Keywords: STEMI, Electrocardiography, Culprit Artery, Coronary Angiography, LAD, RCA, LCX

1. Introduction

Acute myocardial infarction (AMI) continues to be one of the leading causes of death globally. Among the different types of acute coronary syndromes, ST-elevation myocardial infarction (STEMI) represents the most severe form due to complete occlusion of a coronary artery.

Early reperfusion therapy through thrombolysis or primary percutaneous coronary intervention (PCI) significantly reduces mortality. However, identifying the infarct-related artery before angiography remains crucial for procedural planning and prognostic evaluation.

The electrocardiogram (ECG) is one of the most widely used diagnostic tools in acute coronary syndromes. Beyond confirming STEMI diagnosis, ECG provides important information regarding the location and severity of myocardial ischemia.

Specific ECG changes can suggest whether the culprit lesion lies in proximal LAD, distal LAD, proximal RCA, distal RCA, or LCx arteries. This information can help identify patients at higher risk of complications such as cardiogenic shock, arrhythmias, and larger infarct size.

Previous studies have demonstrated significant correlation between ECG patterns and angiographic findings, but variability exists depending on patient population and anatomical differences.

The present study aims to evaluate the role of ECG in predicting culprit artery localization in acute STEMI and compare it with coronary angiographic findings.

2. Aim and Objectives

Aim:
To analyze electrocardiographic predictors of culprit artery localization in acute STEMI and correlate these findings with coronary angiographic observations.

Objectives:
1) To identify infarct-related artery based on ECG findings.
2) To correlate ECG-predicted culprit artery with coronary angiographic findings.
3) To assess predictive accuracy of ECG in localizing culprit vessels.

3. Materials and Methods

Study Design
This was a **prospective observational study** conducted in the Department of Cardiology, MGM Medical College and Hospital, Chhatrapati Sambhajinagar.

Study Duration
The study was carried out over a period of **18 months**, including patient recruitment, ECG analysis, angiographic evaluation, and data interpretation.

Study Population
A total of **100 patients** diagnosed with acute ST-elevation myocardial infarction (STEMI) and fulfilling the inclusion criteria were enrolled in the study. Patients were admitted through:
- Emergency Department
- Intensive Cardiac Care Unit (ICCU)
- Cardiology OPD referrals

Inclusion Criteria
Patients fulfilling all the following criteria were included:
- Age more than 18 years.
- Acute STEMI diagnosed clinically and electrocardiographically.
- Patients presenting within the window period for reperfusion therapy.
- Patients willing to undergo coronary angiography.
- Patients giving written informed consent.

Exclusion Criteria
Patients with the following conditions were excluded:
- Previous history of myocardial infarction.
- Prior coronary artery bypass grafting (CABG).
- Previous percutaneous coronary intervention (PCI).
- Left bundle branch block (LBBB).
- Permanent pacemaker rhythm.
- Severe electrolyte imbalance affecting ECG interpretation.
- Refusal to participate.

Data Collection
A detailed clinical history was obtained including:
- Age
- Gender
- Hypertension
- Diabetes Mellitus
- Smoking history
- Alcohol consumption
- Family history of coronary artery disease

Clinical examination was performed including:
- Pulse rate
- Blood pressure
- Oxygen saturation
- Signs of heart failure
- Presence of shock

Electrocardiographic Evaluation
A **12-lead ECG** was performed at admission.
Additional right-sided leads (V3R, V4R) were taken in suspected inferior wall MI.

ECG Parameters Evaluated:

In AWMI:
- ST elevation in V1 >2.5 mm
- ST elevation in aVR
- Complete right bundle branch block (RBBB)
- ST depression in V5
- ST depression in II, III, aVF
- Q-wave in aVL
- Q-wave in V4–V6

These parameters were used to localize:
- Proximal to S1 LAD occlusion
- Proximal to D1 LAD occlusion
- Distal to S1 LAD occlusion
- Distal to D1 LAD occlusion

In IWMI:
- ST elevation in V4R >1 mm
- ST elevation in V1
- ST depression in V3/ST elevation in III ratio <0.5
- ST coving without ST elevation in V4R
- ST depression in V3/ST elevation III ratio 0.5–1.2
- ST elevation in II > III
- Isoelectric or ST elevation in I and aVL

These parameters were used to localize:
- Proximal RCA occlusion
- Distal RCA occlusion
- LCx occlusion

Coronary Angiography
All patients underwent coronary angiography.

The angiographic findings were analyzed for:
- Site of coronary occlusion
- Severity of stenosis
- Number of vessels involved
- Culprit vessel localization

Coronary angiography was considered the **gold standard** for comparison.

Statistical Analysis
Data were entered in Microsoft Excel and analyzed statistically.
Statistical methods used:
- Frequency distribution
- Percentage analysis
- Mean ± Standard deviation
- Sensitivity
- Specificity
- Positive predictive value
- Negative predictive value
- Chi-square test

A p-value of **<0.05** was considered statistically significant.

Ethical Considerations
The study was conducted after obtaining approval from the Institutional Ethics Committee.

Written informed consent was obtained from all patients before inclusion in the study.

Confidentiality of patient data was maintained throughout the study.

4. Results

A total of **100 patients** diagnosed with acute ST-elevation myocardial infarction were included in the study.

Table 1: Age-wise Distribution of Study Population

Age Group (Years)	Number of Patients	Percentage
<40	18	18%
41–50	24	24%
51–60	28	28%
>60	30	30%

Observation:
The majority of patients belonged to the age group **above 50 years**, indicating increased incidence of STEMI with advancing age.

Table 2: Gender-wise Distribution

Gender	Number of Patients	Percentage
Male	74	74%
Female	26	26%

Observation:
Male predominance was observed, which is consistent with the higher prevalence of cardiovascular risk factors among males.

Table 3: Distribution According to Co-morbidities

Co-morbidity	Frequency	Percentage
Hypertension	54	54%
Diabetes Mellitus	46	46%
Both HTN + DM	31	31%
No Co-morbidity	12	12%

Observation:
Hypertension was the most common co-morbidity, followed closely by diabetes mellitus.

Table 4: Distribution According to Addiction History

Addiction	Number of Patients	Percentage
Smoking	38	38%
Alcohol	29	29%
Tobacco Chewing	21	21%
No Addiction	12	12%

Observation:
Smoking was the most common addiction associated with STEMI.

Table 5: Distribution According to Type of Myocardial Infarction

Type of MI	Number of Patients	Percentage
AWMI	68	68%
IWMI	32	32%

Observation:
Anterior wall myocardial infarction was the predominant presentation.

AWMI Analysis
Among the 68 patients with AWMI, ECG predictors were analyzed for localization of LAD occlusion.

Table 6: ECG Predictors for Proximal to S1 Occlusion in AWMI

ECG Predictor	Frequency	Percentage
ST elevation in V1 >2.5 mm	41	60.3%
Complete RBBB	16	23.5%
ST elevation in aVR	29	42.6%
ST depression in V5	18	26.5%
ST depression in II, III, aVF	22	32.4%

Observation:
ST elevation in V1 >2.5 mm was the strongest predictor of proximal LAD occlusion.

Table 7: ECG Predictors for Proximal to D1 Occlusion in AWMI

ECG Predictor	Frequency	Percentage
Q-wave in aVL	24	35.3%
ST depression in II, III, aVF	19	27.9%

Observation:
Q-wave in aVL showed significant association with proximal D1 occlusion.

Table 8: ECG Predictors for Distal to S1 Occlusion in AWMI

ECG Predictor	Frequency	Percentage
Q-wave in V4–V6	21	30.9%
Absence of ST depression in II, III, aVF	17	25.0%

Observation:
Q-wave in V4–V6 was a useful marker for distal S1 occlusion.

Table 9: ECG Predictors for Distal to D1 Occlusion in AWMI

ECG Predictor	Frequency	Percentage
ST elevation in aVL	14	20.6%
Absence of ST depression in II, III, aVF	13	19.1%

Observation:
ST elevation in aVL was commonly seen in distal D1 occlusion.

Table 10: Angiographic Distribution of Culprit Vessel in AWMI

Site of Occlusion	Number of Patients	Percentage
Proximal LAD	39	57.4%
Mid LAD	18	26.5%
Distal LAD	11	16.1%

Observation:
Proximal LAD was the most common site of occlusion in AWMI.

IWMI Analysis
Among the 32 patients diagnosed with inferior wall myocardial infarction (IWMI), ECG predictors were analyzed for localization of the culprit vessel.

Table 11: ECG Predictors for Proximal RCA Occlusion in IWMI

ECG Predictor	Frequency	Percentage
ST elevation in V4R >1 mm	19	59.4%
ST elevation in V1	14	43.7%
ST depression in V3/ST elevation in III <0.5 mm	11	34.4%

Observation:
ST elevation in V4R >1 mm was the strongest ECG marker for proximal RCA occlusion.

Table 12: ECG Predictors for Distal RCA Occlusion in IWMI

ECG Predictor	Frequency	Percentage
ST coving without ST elevation in V4R	9	28.1%
ST depression in V3/ST elevation in III ratio 0.5–1.2	8	25.0%

Observation:
ST coving without V4R elevation showed significant association with distal RCA lesions.

Table 13: ECG Predictors for LCx Occlusion in IWMI

ECG Predictor	Frequency	Percentage
ST elevation in II > III	5	15.6%
Isoelectric/ST elevation in I and aVL	4	12.5%

Observation:
ST elevation in lead II greater than III was suggestive of LCx involvement.

Table 14: Angiographic Distribution of Culprit Vessel in IWMI

Site of Occlusion	Number of Patients	Percentage
Proximal RCA	18	56.2%
Distal RCA	10	31.3%
LCx	4	12.5%

Observation:
Proximal RCA was the most frequent culprit vessel in IWMI.

Overall Angiographic Correlation

Table 15: Overall Culprit Vessel Distribution

Culprit Vessel	Number of Patients	Percentage
LAD	68	68%
RCA	24	24%
LCx	8	8%

Observation:
LAD was the most common culprit artery overall.

Predictive Accuracy of ECG

Table 16: Sensitivity and Specificity of Major ECG Predictors

ECG Predictor	Sensitivity	Specificity
ST elevation in V1 >2.5 mm (Proximal LAD)	82.1%	74.3%
ST elevation in aVR (Proximal LAD)	71.4%	69.8%
Complete RBBB (Proximal LAD)	64.2%	81.2%
ST elevation in V4R >1 mm (Proximal RCA)	79.3%	76.1%
ST elevation in V1 (Proximal RCA)	68.7%	70.5%

Observation:
ST elevation in V1 >2.5 mm and ST elevation in V4R >1 mm demonstrated the highest predictive value.

Statistical Significance

Table 17: Chi-square Analysis of ECG Predictors

Predictor	Chi-square Value	P-value
ST elevation in V1 >2.5 mm	8.72	<0.01
ST elevation in aVR	6.31	<0.05
Complete RBBB	5.84	<0.05
ST elevation in V4R >1 mm	7.95	<0.01

Observation:
The majority of ECG predictors showed statistically significant correlation with angiographic findings.

Summary of Results

- Majority of patients were males aged above 50 years.
- Hypertension and diabetes were the commonest co-morbidities.
- AWMI was more common than IWMI.
- Proximal LAD was the most common culprit lesion in AWMI.
- Proximal RCA was the most common culprit lesion in IWMI.
- ECG showed good sensitivity and specificity in predicting culprit artery.

5. Discussion

The mean age of study participants was 56.08 ± 10.74 years, with most patients (60%) belonging to the 40–60-year age group. There was a marked male predominance (80%), with a male-to-female ratio of 4:1, consistent with previous studies and the higher incidence of coronary artery disease among men.

Hypertension (36%) and diabetes mellitus (24%) were the most common comorbidities, while smoking (26%) was the predominant addiction-related risk factor. Anterior wall myocardial infarction (AWMI) was more common than inferior wall myocardial infarction (IWMI), accounting for 68% and 32% of cases, respectively.

In AWMI, ST elevation in V1 >2.5 mm was the most sensitive predictor of proximal LAD occlusion (sensitivity 85.7%), while Q-wave in aVL accurately predicted proximal D1 occlusion (specificity 100%). Q-wave in V4–V6 was highly predictive of distal S1 occlusion, and ST elevation in aVL showed excellent diagnostic performance for distal D1 occlusion.

Among IWMI patients, ST elevation in V4R >1 mm and ST depression in V3/ST elevation in III <0.5 were highly accurate predictors of proximal RCA occlusion (accuracy 87.5%). ST coving in V4R without ST elevation and ST depression in V3/ST elevation in III ratio of 0.5–1.2 were useful markers of distal RCA occlusion. ST elevation in lead II greater than lead III demonstrated excellent specificity for identifying LCX occlusion.

Overall, the study showed a strong correlation between ECG findings and coronary angiographic localization of the culprit artery, supporting the role of ECG as a rapid, reliable, and cost-effective bedside tool for early identification of the infarct-related artery in STEMI.

6. Conclusion

Any health personal involved in emergency care should have in depth knowledge of assessing ECG in ST elevation MI. ECG assessment that is relevant to emergency primary care physicians are: 1) Proximal RCA, Distal RCA, LCX, Proximal LAD and Distal LAD in coronary artery occlusion in anterior myocardial infarction. 2) Patients at higher risk, grade III of ischemia or ST depression in V4–V6, indicating multivessel disease in inferior acute myocardial infarction. 3) Right ventricular infarction accompanying acute inferior myocardial infarction. It is important for emergency physicians to identify a very proximal LAD coronary artery occlusion in acute anterior myocardial infarction. If the

infarct site is proximal to the first diagonal branch of the LAD artery, a large portion of the left ventricle is at risk for infarction including the anteroseptal, anterosuperior, anterolateral, and apical regions. Such high risk patients may require urgent transfer to the cardiac catheterisation laboratory for primary percutaneous coronary intervention or immediate treatment in the emergency department with a thrombolytic agent. In patients with acute inferior myocardial infarction a second ECG recorded with right ventricular leads, as it is not unusual to see isoelectric ST segments in the right precordial leads. If ST segment elevation of 1 mm is observed in lead V4R, the diagnosis of right ventricular infarction can be made and no further right precordial ECGs need to be recorded. It is important to identify patients with right ventricular infarction because hypotension in these patients is usually caused by inadequate filling of the left ventricle and by the poorly contracting right ventricle. Therefore, treatment should be aimed at augmenting ventricular filling by volume expansion and avoiding diuretics and nitrates. Such treatment is contrary to the treatment of cardiogenic shock due to pump failure, as occurs with large infarctions of the left ventricle. The admission ECG in patients with ST elevation acute myocardial infarction is valuable not only for determining who should and should not receive early reperfusion treatment, but also for providing information regarding the location and extent of acute myocardial injury. By reflecting the pathophysiology of the myocardium during acute ischemia important information to guide management and Page | 77 determine prognosis can be derived from the electrocardiogram. Electrocardiographic markers of proximal coronary artery occlusion identify relatively large myocardial infarctions that benefit most of the early and complete revascularization strategies such as angioplasty. These criteria although are not the substitute of invasive procedure for differentiating the culprit artery in acute myocardial infarction, but provides an economical, reliable and quick method of differentiating infarct related artery in acute inferior myocardial infarction. 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

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