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Original Research

Electrocardiogram As A Simple Non Invasive Tool In Identifying Affected Vessels In Acute Coronary Syndrome And To Find Its Relation With 2d Echo And Coronary Angiography

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Abstract
Background: Coronary artery disease (CAD) is a leading cause of cardiovascular-related mortality worldwide, with ischemic heart disease accounting for approximately 16% of all deaths. ST-elevation myocardial infarction (STEMI), characterized by sustained ST-segment elevation on an electrocardiogram (ECG) and elevated biomarkers of myocardial necrosis, results from obstruction of coronary arteries. Traditional diagnosis involves ECG and coronary angiography (CAG), which reveal different aspects of pathogenesis. This study aims to assess the correlation between ECG-based localization of infarct area and findings from coronary angiography and 2D echocardiography (2D Echo) in patients with STEMI.
Materials and Methods: This cross-sectional, observational study was conducted at the Department of General Medicine, SAMC & PGI, Indore, over 18 months. A total of 150 newly diagnosed STEMI patients were included, divided into younger (<45 years) and older (≥45 years) age groups. ECGs were analyzed, and patients were categorized based on infarct location. Investigations included routine blood tests, cardiac enzymes, 2D Echo, and coronary angiography. Data were analyzed using SPSS, with continuous variables presented as mean ± SD and categorical variables as percentages. Statistical significance was set at $p<0.05$.
Results: The majority of ACS patients were aged 51-60 years (32.7%) and male (80.7%). Hypertension was the most common comorbidity (42%), and 35.3% were smokers. Anterior wall MI was the most frequent ECG finding (65.4%), with corresponding anterior wall hypokinesia observed in 65.3% of 2D Echo results. Coronary angiography revealed left anterior descending artery occlusion in 83.3% of patients. Significant correlations were found between ECG findings and both CAG and 2D Echo results. No significant correlation was found between smoking status and ECG findings.
Conclusion: The admission ECG in STEMI patients is crucial for identifying the infarct location and extent, guiding management, and determining prognosis. ECG findings correlate significantly with coronary artery occlusions identified by CAG. Thus, ECG remains a valuable, accessible, and cost-effective tool in the initial assessment and management of STEMI patients.
Keywords: Coronary artery disease, ST-elevation myocardial infarction, ECG, coronary angiography, 2D echocardiography, myocardial infarction, cardiovascular mortality, ischemia.

Introduction

Coronary artery disease (CAD) is a serious cardiovascular illness that affects people worldwide, significantly impacting long-term mortality and morbidity in both affluent and developing countries (1). Ischemic heart disease is responsible for approximately 16% of all deaths globally, with a noted increase in CAD incidence according to epidemiological surveys (2). The screening and assessment of CAD typically rely on traditional symptoms, indicators, and associated comorbidities. Symptoms of CAD include silent ischemia, stable angina pectoris, unstable angina, ST-elevation myocardial infarction (STEMI), heart failure, and sudden death (3,4).
STEMI is characterized by myocardial ischemia with a sustained ST-segment elevation on the electrocardiogram (ECG) and the subsequent release of biomarkers of myocardial necrosis (5). It is primarily caused by the obstruction of one or more coronary arteries, which supply blood to the heart. This obstruction

often results from plaque rupture, erosion, fissuring, or dissection of the coronary arteries, leading to an obstructive thrombus. Significant risk factors for STEMI include dyslipidemia, diabetes, hypertension, smoking, and a family history of coronary artery disease (6,7). The 12-lead ECG is a crucial tool in diagnosing and initially evaluating individuals with chest pain. Patients presenting with ST-elevation and new left bundle branch block are typically referred for early reperfusion therapy, while those with minor ST deviation or predominantly ST depression are initially managed conservatively (8,9). Based on the patterns of ST deviation, patients can be diagnosed with anterior, inferior-posterior, or lateral myocardial infarction. The risk is often assessed using crude evaluations of the absolute magnitude of ST-segment deviation or the breadth of the QRS complexes (10,11). The first ECG provides valuable information about the exact location of the infarct-related lesion, prediction of final infarct size, and prognosis estimation without additional costs or effort. Despite the increased use of primary coronary interventions in STEMI patients, there are still many cases where identifying the infarct-related site and estimating the myocardial area supplied by each branch distal to the infarct-related coronary artery occlusion is challenging, even with immediate coronary angiography (12,13). In acute myocardial infarction, the ECG and coronary angiography each reveal different aspects of pathogenesis. While coronary angiography provides information on vascular anatomy, electrocardiograms indicate the myocardial physiology during acute ischemia. Severe coronary stenoses can be detected via angiography even in the absence of overt ECG evidence of acute ischemia. Conversely, angiography can reveal the return of normal vascular patency even if the ECG shows persistent ischemia due to "no-reflow," reperfusion injury, or preexisting myocardial damage. Thus, acute myocardial ischemia is best detected by ECG, while coronary angiography remains the gold standard for localizing the artery responsible for the infarct (14,15). Current imaging techniques like contrast ventriculography, echocardiography, and radionuclide perfusion studies cannot differentiate between ischemic but viable myocardium and necrotic myocardium during the acute stage of myocardial infarction (16,17). There is a notable lack of literature on the relationship between the infarct area as determined by an electrocardiogram and the area seen on a coronary angiogram in individuals with STEMI. This investigation aims to evaluate the correlation between ECG-based localization of the infarct region and findings from coronary angiography and 2D echocardiography in STEMI patients.

Materials and Methods

Study Design: This study is a cross-sectional, observational study.
Study Location: The study was conducted in the Department of General Medicine, SAMC & PGI, Indore.
Duration of Study: The duration of the study was 18 months.

Inclusion Criteria

1. Newly diagnosed patients with myocardial infarction.
2. Patients with chest pain lasting more than 30 minutes or those with symptoms of angina equivalents accompanied by ST-segment elevation.
3. Patients with confirmed enzymatic changes.
4. Patients suitable for angiography who have no contraindications to the administration of iodinated contrast.
5. Patients without implanted pacemakers or valve prostheses.

Exclusion Criteria

1. Patients who had previous angioplasty of coronary vessels.
2. Patients with a history of prior coronary artery bypass graft surgery.
3. Patients with severe valvular heart disease other than ischemic mitral regurgitation and congenital cardiac anomaly.
4. Patients with implanted pacemakers or valve prostheses.

Sample Size: A total of 150 newly diagnosed patients, both male and female, were included in the study over a period of one and a half years.

Procedure

Patients were divided into two groups based on age:

- Younger age group: <45 years with acute coronary syndrome (ACS)
- Older age group: ≥45 years with ACS

A standard 12-lead ECG was recorded and analyzed by a single experienced person who was blinded to both the patient history and angiographic findings. Patients were categorized into five groups based on ECG criteria:

1. Anterior wall MI
2. Inferior wall MI
3. Lateral wall MI

4. Right ventricular MI (RVMI)
5. Posterior wall MI (PWMI)

Each group was further divided into subgroups based on the site of occlusion within the artery.

Investigations

- **Routine Investigations**: Complete blood count, urea, creatinine, electrolytes, SGOT, SGPT, RBS, HbA1C, TSH.
- **Special Investigations**: TROP – T, CPKMB, 2D echocardiography, and coronary angiography.

Coronary Angiogram (CAG)

Coronary angiography was performed using the 5F Tiger catheter technique, and coronary angiograms were visually analyzed by an experienced cardiologist. The degree of luminal narrowing was given as a percentage of the pre-stenotic diameter. The artery was considered:

- Normal (0%)
- Mild stenosis (<50%)
- Moderate stenosis (51–70%)
- Significant critical stenosis (>70%)

Statistical Analysis

Data were recorded using Microsoft Excel and analyzed with the SPSS program for Windows, version 25 (SPSS, Chicago, Illinois). Continuous variables were presented as mean ± SD, and categorical variables as absolute numbers and percentages. Data normality was checked before statistical analysis. Descriptive analysis was performed to obtain general characteristics of the study population. Categorical variables were analyzed using the chi-square test or Fisher's exact test. A p-value of <0.05 was considered statistically significant.

Results

The study involved 150 newly diagnosed patients with acute coronary syndrome (ACS) to assess the relationship between ECG-based localization of infarct area and its correlation with coronary angiography and 2D echo findings. The demographic and clinical characteristics of the study population are presented in the tables below.

Table 1: Age Distribution of Patients with ACS

Age (years)	Frequency of ACS	Percent (%)
≤30	3	2.0
31-40	17	11.3
41-50	42	28.0
51-60	49	32.7
61-70	33	22.0
>70	6	4.0
Total	150	100.0

In the present study, the majority of patients with acute coronary syndrome belonged to the age group of 51-60 years (32.7%), followed by 41-50 years (28%), and 61-70 years (22%).

Table 2: Frequency of ACS in Different Age Groups

Age Groups	Frequency of ACS	Percent (%)
<45 years	34	22.6
≥45 years	116	87.4
Total	150	100.0

Most patients who presented with ACS were in the older age group (87.4%).

Table 3: Sex Distribution of Patients with ACS

Sex	Frequency of ACS	Percent (%)
Female	29	19.3
Male	121	80.7
Total	150	100.0

The majority of ACS cases were observed in males (80.7%).

Table 4: Frequency of Sex Distribution among the Younger Age Group Patients with ACS

Sex	Frequency of ACS in <45 years	Percent (%)
Female	6	17.6
Male	28	82.4
Total	34	100.0

Among younger patients (<45 years), 82.4% were male, and 17.6% were female.

Table 5: Frequency of Sex Distribution among the Older Age Group Patients with ACS

Sex	Frequency of ACS in ≥45 years	Percent (%)
Female	23	19.8
Male	93	80.2
Total	116	100.0

Among older patients (≥45 years), 80.2% were male, and 19.8% were female.

Table 6: Comorbidities Associated with ACS

Comorbidities	Frequency	Percent (%)
COPD	4	2.7
HTN	63	42.0
Hypothyroidism	7	4.7
Old CVA	3	1.7
T2DM	11	7.3
No Comorbidities	64	42.7
Total	150	100.0

Hypertension (42%) was the most common comorbidity associated with ACS, followed by diabetes (7.3%).

Table 7: Distribution as per Smoking Status with Respect to ACS Presentation

Smoking	Young (<45 years)	Old (≥45 years)
	Frequency of ACS	Percent (%)
Yes	15	28.3
No	5	5.2
Total	20	100.0

Smoking was more commonly seen in older age group patients (71.7%) compared to younger patients (28.3%).

Table 8: Distribution of Young Smoker Patients According to Territory of Involvement as per CAG

Vessels	Frequency Young (<45 years)	Percentage (%)
SVD	9	60.0
DVD	5	33.33
TVD	1	6.67
Total	15	100.0

Among young smokers, the majority had single-vessel disease (60%).

Table 9: Distribution as per Family History of MI

Family History of MI	Frequency	Percent (%)
No	132	88.0
Yes	18	12.0
Total	150	100.0

Only 12% of ACS patients had a family history of myocardial infarction.

Table 10: ECG Findings in Patients with ACS

ECG Findings	Frequency	Percent (%)
AWMI	98	65.4
IWMI	33	22.0
IWMI+RVMI	9	6.0
LWMI	7	4.7
PWMI	3	2.0
Total	150	100.0

The majority of patients had anterior wall MI (65.4%).

Table 11: 2D Echo Findings in Patients with ACS

2D Echo Findings	Frequency	Percent (%)
Anterior wall hypokinesia	98	65.3
Inferior wall hypokinesia	45	30.0
Anterolateral wall hypokinesia	7	4.7
Inferobasal and right lateral wall hypokinesia	9	6.0
Total	150	100.0

The 2D echo revealed that anterior wall hypokinesia was present in the majority of patients (65.3%).

Table 12: Distribution of Occlusion as per CAG

Blood Vessels	Findings	Frequency	Percent (%)
LAD	Abnormal	125	83.3
	Normal	25	16.7
LCX	Abnormal	65	43.3
	Normal	85	56.7
RCA	Abnormal	94	62.7
	Normal	56	37.3

The left anterior descending artery (LAD) was the most frequently occluded vessel (83.3%).

Table 13: Distribution as per Severity of ACS

Severity of ACS	AWMI	IWMI	IWMI+ RVMI	LWMI	PWMI	Frequency	Percent (%)
Mild (≤ 50%)	9	3	0	0	0	12	8.0
Moderate (50-70%)	53	15	2	2	2	75	49.3
Severe (>70%)	35	15	7	5	1	63	42.0
Recanalyzed Vessel	1	0	0	0	0	1	0.7
Total	98	33	9	7	3	150	100.0

Most patients had moderate ACS (49.3%), followed by severe ACS (42.0%).

Table 14: Correlation between ECG Findings and Age Groups

Age Groups	AWMI (%)	IWMI (%)	IWMI+RVMI (%)	LWMI (%)	PWMI (%)	Total	P-value
<45 years	24 (70.5)	6 (17.6)	3 (8.8)	1 (2.9)	0 (0)	34	0.021
≥45 years	74 (63.9)	27 (23.2)	6 (5.17)	6 (5.17)	3 (2.5)	116	
Total	98	33	9	7	3	150	

There was a significant correlation between age groups and ECG findings (p=0.021).

Table 15: Correlation between ECG Findings and Sex

Sex	AWMI (%)	IWMI (%)	IWMI+RVMI (%)	LWMI (%)	PWMI (%)	Total	P-value
Female	17	3	5	3	1	29	0.004
Male	81	30	4	4	2	121	
Total	98	33	9	7	3	150	

There was a significant correlation between sex and ECG findings (p=0.004).

Table 16: Correlation between ECG Findings and Smoking Status

Smoking Status	AWMI (%)	IWMI (%)	IWMI+RVMI (%)	LWMI (%)	PWMI (%)	Total	P-value
Non-Smoker	65 (67.0)	23 (23.7)	4 (4.1)	4 (4.1)	1 (1.0)	97	
Smoker	33 (62.3)	10 (18.9)	5 (9.4)	3 (5.7)	2 (3.8)	53	
Total	98	33	9	7	3	150	

Among smokers, the majority had anterior wall MI (62.3%), with a significant correlation found between smoking status and ECG findings (p=0.038).

Table 17: Correlation between ECG and 2D Echo Findings

ECG Findings	Anterior Wall Hypokinesia	Inferior Wall Hypokinesia	Anterolateral Wall	In ferobasal and Right Lateral	Total	P-value

	(%)	(%)	Hypokinesia (%)	Wall Hypokinesia (%)		
AWMI	98	0	0	0	98	<0.001
IWMI	0	33	0	0	33	
IWMI+RVMI	0	0	0	9	9	
LWMI	0	0	7	0	7	
PWMI	0	3	0	0	3	
Total	98	36	7	9	150	

There was a significant correlation between ECG findings and 2D echo findings (p<0.001). (Graph 1)

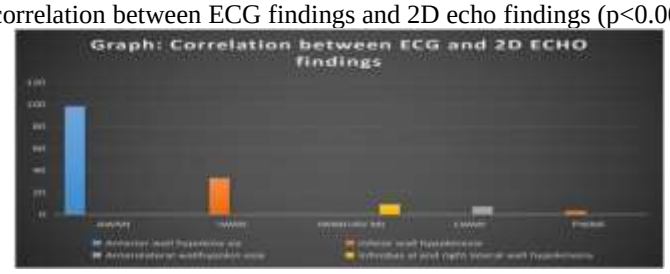


Table 18: Correlation between ECG Findings and LAD Occlusion Status as per CAG

LAD Occlusion Group	AWMI (%)	IWMI (%)	IWMI+RVMI (%)	LWMI (%)	PWMI (%)	Total	P-value
Abnormal	89	22	6	6	2	125	0.023
Normal	9	11	3	1	1	25	
Total	98	33	9	7	3	150	

There was a significant correlation between LAD occlusion and ECG findings (p=0.023). (Graph 2)

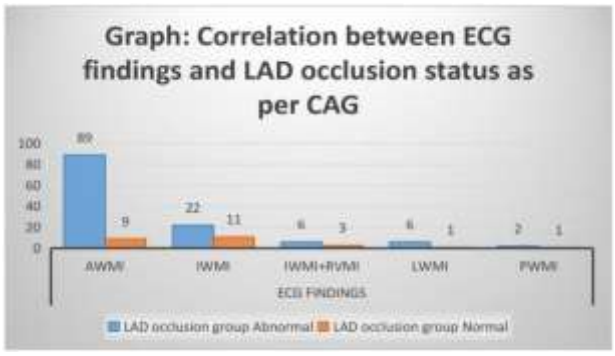


Table 19: Correlation between ECG Findings and LCX Occlusion Status as per CAG

LCX Occlusion Group	AWMI (%)	IWMI (%)	IWMI+RVMI (%)	LWMI (%)	PWMI (%)	Total	P-value
Abnormal	35	14	7	6	3	65	0.004
Normal	63	19	2	1	0	85	
Total	98	33	9	7	3	150	

There was a significant correlation between LCX occlusion and ECG findings (p=0.004). (Graph 3)

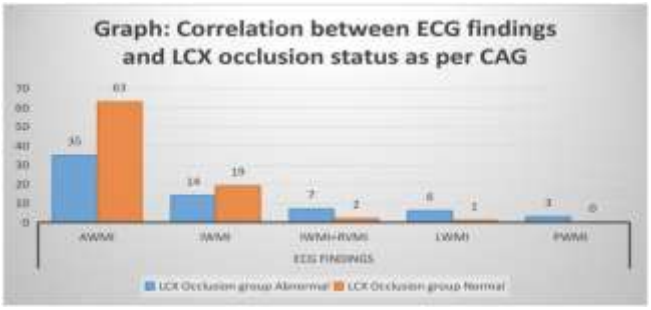


Table 20: Correlation between ECG Findings and RCA Occlusion Status as per CAG

RCA Occlusion	AWMI	IWMI	IWMI+RVMI	LWMI	PWMI	Total	P-

Group	(%)	(%)	(%)	(%)	(%)		value
Abnormal	20	43	9	5	3	94	<0.001
Normal	68	0	0	2	0	56	
Total	98	33	9	7	3	150	

There was a significant correlation between RCA occlusion and ECG findings (p<0.001).(Graph 4)

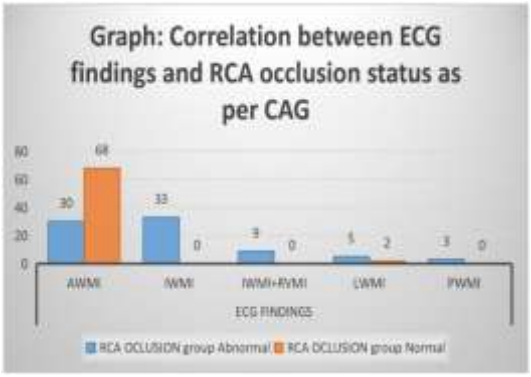
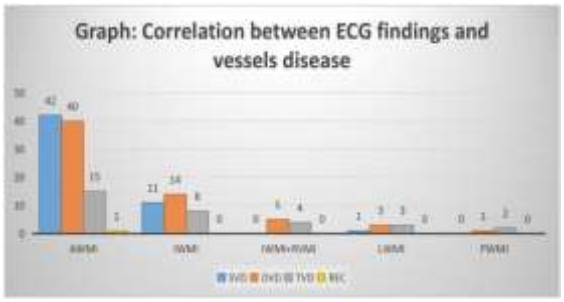


Table 21: Correlation between ECG Findings and Vessels Disease

Vessel Disease	AWMI (%)	IWMI (%)	IWMI+RVMI (%)	LWMI (%)	PWMI (%)	Total	Percent (%)
SVD	42	11	0	1	0	54	36.0
DVD	40	14	5	3	1	63	42.0
TVD	15	8	4	3	2	32	21.3
Recanalyzed	1	0	0	0	0	1	0.7
Total	98	33	9	7	3	150	100.0

The majority of patients with single-vessel disease (SVD) had anterior wall MI (77.7%).(Graph 5)



This detailed result description provides a clear overview of the findings, correlations, and significance of various parameters in the study population.

Discussion

Coronary artery disease (CAD) remains a leading cause of morbidity and mortality globally, significantly affecting both developed and developing nations (1). Ischemic heart disease accounts for approximately 16% of all deaths worldwide, highlighting its significant burden (2). This study aimed to evaluate the correlation between ECG-based localization of infarct regions and findings from coronary angiography and 2D Echo in patients with ST-elevation myocardial infarction (STEMI).

In our study, the majority of ACS patients were over the age of 45 (87.4%), consistent with other findings where ACS predominantly affects older individuals (3). The male predominance (80.7%) in ACS cases also aligns with previous studies showing higher incidence rates among men, possibly due to risk factors like smoking and hormonal differences (4, 5). Similar patterns were observed in studies conducted in Rajasthan and other regions of India (6, 7).

Hypertension and diabetes emerged as the most common comorbidities, found in 42.7% and 7.4% of patients respectively. These comorbidities are well-documented risk factors for CAD (8). The prevalence of hypertension in our study mirrors findings from other Indian cohorts and highlights the increasing burden of hypertension as a critical public health issue (9, 10).

Smoking was a significant risk factor, particularly among younger patients, where it was the most significant risk factor for coronary events (11). This aligns with the INTERHEART study, which identified smoking as a

major risk factor for myocardial infarction in young adults (12). Our study showed that 35.3% of ACS patients were smokers, a prevalence consistent with other Indian studies (13).

Family history of myocardial infarction was present in 12% of patients, underscoring the genetic predisposition to CAD (14). The ECG findings in our study indicated that anterior wall MI was the most common presentation (65.4%), which is in agreement with studies that report anterior wall MI as the predominant type of myocardial infarction (15, 16).

The 2D Echo findings correlated strongly with ECG results, with anterior wall hypokinesia being the most frequent abnormality (65.3%). This finding is consistent with the literature indicating high sensitivity and specificity of 2D Echo in detecting regional wall motion abnormalities in acute myocardial infarction (17, 18).

Coronary angiography revealed that the left anterior descending artery (LAD) was the most frequently occluded vessel (83.3%), followed by the right coronary artery (RCA) (62.7%) and the left circumflex artery (LCX) (43.3%). These results are consistent with other studies that show a high incidence of LAD involvement in STEMI (19, 20).

Our study found significant correlations between ECG findings and angiographic findings. Specifically, LAD occlusion was most commonly associated with anterior wall MI, RCA with inferior wall MI, and LCX with lateral wall MI. These correlations are crucial for guiding management and prognostication in STEMI patients (21, 22)

Conclusion.

In conclusion, our study demonstrates that ECG is a valuable, sensitive, and specific tool for identifying the involved coronary artery in acute ST-elevation MI. It provides critical information for guiding management and determining prognosis, especially when angiography is not immediately available. This reinforces the role of ECG as an indispensable diagnostic tool in the initial assessment and management of STEMI.

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