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Diagnostic Accuracy of Electrocardiography for Diagnosis of Coronary Artery Disease in Patients Undergoing Coronary Angiography

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[1-2]Substantial contributions to the conception or design of the work; or the acquisition, analysis, or interpretation of data for the work

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A B S T R A C T

Objective: To determine the diagnostic accuracy of electrocardiography for diagnosis of coronary artery disease taking coronary angiography as gold standard

Methodology: This Cross-sectional, validation research was conducted in the department of Cardiology, Punjab Institute of Cardiology, Lahore from August 2025 to January 2026. After obtaining informed consent and demographics, patients underwent ECG and findings were recorded. Cases were labeled as positive or negative for coronary artery disease if ECG was abnormal or normal, respectively. All patients then underwent coronary angiography. On coronary angiography, if >50% stenosis was present in one or more coronary artery, then it was confirmed as positive coronary artery disease. Data was noted in proforma and analyzed in SPSS v27.

Results: Mean age of enrolled cases 51.13 ± 11.84 years. There were 88 (55%) men and 72 (45%) women in whole sample. On angiography, there were 82 (51.25%) positive patients for CAD while 78 (48.75%) were negative. On coronary angiography, it has been observed that single vessel-disease was present in 52 (32.5%) cases, double vessel-disease in 65 (40.6%) cases and triple vessel-disease in 43 (26.9%) cases. By comparing findings of ECG with coronary angiography, it has been observed that ECG attained Sensitivity of 89.0%, Specificity of 69.2%, PPV of 75.3%, NPV of 85.7% and diagnostic accuracy of 79.4%.

Conclusion: It has been concluded that ECG can be a reliable tool for detection of coronary artery disease. Further researches are required to confirm evidence.

Key words: coronary angiography, coronary artery disease, diagnostic accuracy, electrocardiography, stenosis.

Introduction

Determining the aetiological reason is crucial in the first assessment of individuals with heart failure and systolic ventricular dysfunction. [1, 2] Finding that ischemia is the underlying cause of ventricular dysfunction might have serious therapeutic consequences, even if the therapy of heart failure is similar for all aetiological entities.[3, 4] In about 31.8% subjects, ECG showed abnormal ST changes.[5] Coronary angiography has been regarded as the preferred method for verifying the existence of coronary disease and is a commonly used diagnostic procedure in patients with systolic ventricular failure. According to current clinical practice recommendations, coronary angiography has a level of evidence of B and an indication of IIb. However, there are no particular clinical investigations that have assessed this indication's diagnostic efficacy.[6, 7]

Since acute coronary syndromes account for the majority of cardiac arrests, it is generally accepted that patients who exhibit ST-segment elevation on the electrocardiogram (ECG) following the restoration of spontaneous circulation should have coronary angiography done very away. Acute coronary occlusions with substantial stenosis appropriate for revascularization are common in these individuals, according to retrospective investigations.[8] On the one hand, even after cardiac arrest, ST-elevations on the ECG appear to have a good positive predictive value in identifying acute coronary lesions. Therefore, it would seem sense to assume that prompt coronary angiography would be advantageous for these individuals. However, it appears that the ECG's negative predictive value is decreased following the resumption of spontaneous circulation. The utility of ECG as a reliable tool for diagnosing coronary artery occlusion has been called into question by a number of studies that have revealed rates of acute coronary occlusion of around 30% and a high incidence of severe coronary artery stenosis in individuals without ST-elevation.[8, 9] Therefore, coronary angiography continues to be the "Gold Standard" for determining the artery associated with an infarct and the occurrence of an acute ischemic event.[10]

Determining the diagnostic accuracy of electrocardiography for the identification of coronary artery disease in patients having coronary angiography was the rationale for this investigation. In routine, ECG is first line investigative tool for detection of ischemic changes. But literature showed

that there is discrepancy in accuracy rate of ECG for detection of coronary artery disease. But limited work has been done before in this regard. Therefore, this study has been planned to check whether ECG is reliable tool or coronary angiography is still a gold standard. This would enable us to refine our methods and use the results in a local context.

Methodology

After taking CPSP synopsis approval RMTC CRD 2022-070-2894 from institutional review board. This cross-sectional research was conducted from August 2025 to January 2026 at the Punjab Institute of Cardiology's Department of Cardiology in Lahore. A sample size of 160 patients is determined with a 95% confidence level, a percentage of coronary artery disease of 31.8%, an ECG sensitivity of 33.7%, and a specificity of 66.0% with a 13% margin of error using a sensitivity and specificity calculator. [11] The patients, who fulfilled following selection criteria were enrolled after applying Non-probability, consecutive sampling technique.

Suspected cases of age 30-70 years, either gender, undergoing electrocardiography for chest pain, followed by coronary angiography were included. Patients with repeat myocardial infarction, valvular disease of heart, and rheumatic disease of heart or already underwent primary PCI or bypass surgery were excluded.

After obtaining written informed consent, demographics including name, age, gender, duration of symptoms (chest pain), residence, occupation, life style, history of smoking (>5 pack years), alcoholism (>20 ml/day), diabetes (BSR> 200 mg/dl), hypertension (BP≥140/90 mmHg), dyslipidemia (total cholesterol >200 mg/dl), family history of coronary artery disease were noted. Then patients underwent ECG by researcher and ECG findings were recorded. Patients were labeled as positive or negative for coronary artery disease if ECG was abnormal or normal, respectively. When there are ST-segment abnormalities, such as a horizontal or downward oblique depression ≥0.1 mv, the ECG is considered abnormal. After the J point, the J-point ST segment descends by at least 2 mm and 80 ms. Diagnostic criteria for subepicardial or transmural myocardial ischemia include ST-segment elevation ≥1 mm in two or more limb leads or ≥2 chest leads joint ST segment elevation ≥2 mm. The condition is characterized by ST-segment elevation at the beginning of symptoms. All patients then underwent coronary angiography as per standard protocol. On coronary angiography, coronary vessel involved with >50% stenosis was noted. If >50% stenosis was present in one or more coronary artery, then it was confirmed as positive coronary artery disease. Data was noted in proforma by the researcher.

All statistical analyses was done using SPSS ver. 27.0. Normality was checked by using Shapiro-Wilk test. Quantitative variables like age, duration of symptoms, stenosis level were described as mean ± SD. Categorical variables like gender, residence, occupation, life style, history of diabetes, smoking, alcoholism, hypertension, dyslipidemia, family history of coronary disease, coronary artery disease (on ECG and angiography) were given as percentages and frequencies. Using angiography as the gold standard, a 2x2 table was created to determine the ECG's sensitivity, specificity, PPV, NPV, and diagnostic accuracy.

Results

In this study, we enrolled total 160 patients with the mean age of 51.13 ± 11.84 years. On angiography, there were 82 (51.25%) positive patients for CAD while 78 (48.75%) were negative. There were about 75 (46.9%) patients who fell in age range 30-50 years and 85 (53.1%) fell in age range 51-70 years. There were 88 (55%) men and 72 (45%) women in whole sample. The mean duration of symptoms was 6.42 ± 3.42 hours. Most of the patients present from urban and semi-urban region. There were 46 (28.8%) smokers, 21 (13.1%) were alcoholic, about 93 (58.1%) patients had diabetes mellitus, while 114 (71.3%) had hypertension, 89 (55.6%) had dyslipidemia and 77 (48.1%) cases had positive family history of coronary artery disease. Out of 160 cases, mostly were doing job and had sedentary lifestyle (70.6%), followed by housewives (29.4%) while few were farmers or doing business or retired. On coronary angiography, mean stenosis was observed was 53.53 ± 19.09% and mean stenosis in positive patients was significantly higher (69.33 ± 11.61%) as compared to negative patients (36.92 ± 8.08). Table I

On coronary angiography, it has been observed that single vessel disease was present in 52 (32.5%) cases, double vessel disease in 65 (40.6%) cases and triple vessel disease in 43 (26.9%) cases. Figure 1

By comparing findings of ECG with coronary angiography, it has been observed that ECG attained Sensitivity of 89.0%, Specificity of 69.2%, PPV of 75.3%, NPV of 85.7% and diagnostic accuracy of 79.4%. Table II

Table I: Basic demographic details of cases with and without coronary artery disease. (n = 160)

Characteristics	N(%)	CAD	
		Positive	Negative
	160	82	78
Patient's age, in years	51.13 ± 11.84	50.34 ± 11.34	51.96 ± 12.37
Age 30-50 years	75 (46.9%)	42 (51.2%)	33 (42.3%)

Age 51-70 years	85 (53.1%)	40 (48.8%)	45 (57.7%)
Gender			
Male	88 (55%)	48 (58.5%)	40 (51.3%)
Female	72 (45%)	34 (41.5%)	38 (48.7%)
Duration of symptoms, in hours	6.42 ± 3.42	6.76 ± 3.63	6.06 ± 3.17
Residence			
Rural	42 (26.3%)	19 (23.2%)	23 (29.5%)
Urban	60 (37.5%)	37 (45.1%)	23 (29.5%)
Semi-urban	58 (36.3%)	26 (31.7%)	32 (41.0%)
History of:			
Smoking	46 (28.8%)	21 (25.6%)	25 (32.1%)
Alcoholism	21 (13.1%)	11 (13.4%)	10 (12.8%)
Diabetes mellitus	93 (58.1%)	52 (63.4%)	41 (52.6%)
Hypertension	114 (71.3%)	60 (73.2%)	54 (69.2%)
Dyslipidemia	89 (55.6%)	49 (59.8%)	40 (51.3%)
Family history of coronary artery disease	77 (48.1%)	47 (57.3%)	30 (38.5%)
Occupation			
Farmer	10 (6.3%)	5 (6.1%)	5 (6.4%)
Job	69 (43.1%)	36 (43.9%)	33 (42.3%)
Business	19 (11.9%)	11 (13.4%)	8 (10.3%)
Retired	15 (9.4%)	7 (8.5%)	8 (10.3%)
Housewife	47 (29.4%)	23 (28.0%)	24 (30.8%)
Lifestyle			
Active	47 (29.4%)	21 (25.6%)	26 (33.3%)
Sedentary	113 (70.6%)	61 (74.4%)	52 (66.7%)
Stenosis on coronary angiography	53.53 ± 19.09	69.33 ± 11.61	36.92 ± 8.08*

* = independent samples t-test was applied that was significant (p<0.0001).

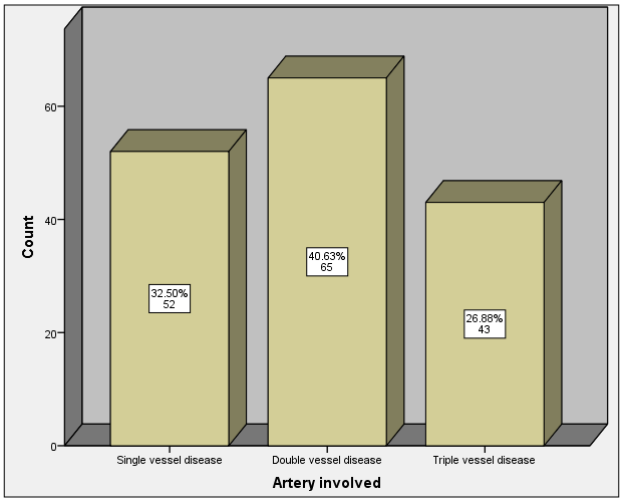

Figure 1. Distribution of patients according to severity of vessel disease (n = 160)

Table II: Accuracy of electrocardiography for detection of coronary artery disease taking coronary angiography as gold standard.

		Angiography		Total
		Positive	Negative	
ECG	Positive	73	24	97
	Negative	9	54	63
Total		82	78	160

Sensitivity: 73/82*100=89.0%
Specificity: 54/78*100=69.2%
PPV: 73/97*100=75.3%
NPV: 54/63*100=85.7%
Diagnostic accuracy: (73+54)/160=79.4%

Discussion

In our study, we observed that ECG attained Sensitivity of 89.0%, Specificity of 69.2%, PPV of 75.3%, NPV of 85.7% and diagnostic accuracy of 79.4%.

Worldwide, the 12-lead electrocardiogram (ECG) is a cheap, accessible, and noninvasive medical procedure. Traditional characteristics, including q-waves or decreased R-wave amplitudes, are frequently employed to identify or suspect coronary artery disease.[12] Using biomarkers such as an increase in troponin with at least one value greater than the 99th percent upper reference limit, ECG is a staple in the diagnosis of acute myocardial infarction. [3, 13, 14] Depending on the ECG appearance, myocardial infarctions in emergency rooms are categorized as either non-STEMI, which requires conservative therapy or early intervention, or ST-segment elevation myocardial infarction (STEMI), which necessitates urgent reperfusion treatment. Although the first ECG is frequently not diagnostic and a serial ECG is necessary, it also offers information on the location, length, and extent of the myocardial infarction. [14] The electrical activity of the heart is provided by ECG beats, which may also be utilized to identify a number of cardiac disorders. The P-wave, QRS-complex, and T-wave that make up each beat signify the depolarization and repolarization of the heart muscles.[15-17]

Liu et al., conducted a study and found that conventional ECG had 33.7% sensitivity and 66.0% specificity for detection of coronary artery disease (ischemic changes) in symptomatic patients.[11] Mahmoodzadeh et al., carried performed a similar investigation and found that, with an overall sensitivity of 51.5% and specificity of 66.1%, ECG accurately identified severe stenosis in 176 out of 400 patients.[18] While Ghadrdoost et al., investigated 390 cardiac patients and found that, in comparison to coronary angiography, CG produced a sensitivity of 29% and a specificity of 67%. They found that the 12-lead ECG is not a good way to identify coronary artery disease.[19]

According to Knuuti et al.'s meta-analysis, ECG had an average sensitivity of 58% and specificity of 62% for obstructive coronary artery disease.[20] Only ECG-EST was examined in Banerjee et al.'s meta-analysis. Overall, it was discovered that ECG-EST had 79% sensitivity and 69% specificity for obstructive CAD.[21]

In a study by Schlegel et al., It was claimed that the sensitivity of a typical 12-lead ECG at rest for identifying coronary artery disease is poor. They found that the ECG score that was validated in the training set improved the specificity from 85% to 94% ($P < 0.05$) and the sensitivity of the resting ECG for detecting illness in the test set from 78% to 92% ($P < 0.0001$). They came to the conclusion that when it comes to coronary artery disease screening, resting 12-lead A-ECG grading is more accurate than purely traditional ECG.[22]

Conclusion

It has been concluded that ECG can be a reliable tool for detection of coronary artery disease and can help to avoid unnecessary angiography especially in negative cases. On the basis of initial findings of ECG, treatment can be initiated and morbidity and mortality can be prevented. Further studies are required to confirm the evidence.

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