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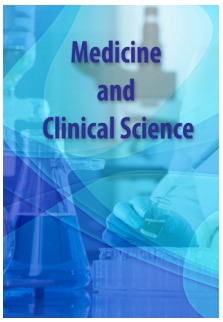

Electrocardiography Diagnostic performance in the assessment of significant coronary artery disease and its anatomical site in comparison with coronary angiography among Nigerians: A pilot study

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Keywords

Electrocardiogram, Angiography, Coronary Artery Disease, Sensitivity, Specificity

Abstract

Introduction: Coronary angiography (CAG) is a useful diagnostic tool in patients with suspected CAD especially in patients that are at high risk. CAG is the gold standard for diagnosis of significant coronary stenosis. However, it can be associated with certain risks. The use of noninvasive assessment tools for predicting CAD is considered because it offers safety, patient convenience, and faster performance. The aim of the study was to assess the predictive value of 12-lead electrocardiogram (ECG) in patients with suspected coronary artery disease (CAD).

Methods: 59 consecutive patients aged 40 to 98 years with new onset of chest pain that were referred to the cardiac catheterization laboratory of Bayelsa Specialist Hospital, Yenagoa October 2017 and November, 2018. At admission, a resting standard 12-lead ECG was recorded and the ECG changes were interpreted by the cardiologist. The ECG was recorded as normal or abnormal depending on regional changes in ST segment (ischemic-appearing ST depression or elevation), T-wave inversion (≥ 1 mm) and Q-wave appearance (≥ 0.04 s or ≥ 25% of R-wave amplitude). The III, aVF and II leads were used to detect RCA involvement; V2 or V3 and aVL to detect LCx involvement, and V2 or V3, V1, and V4 were used to detect LAD involvement. ECGs were taken at a paper speed of 25 mm/s and calibration of 10 mm.

Results: ECG correctly detected significant stenosis in 21 out of 59 patients with an overall sensitivity per patient of 59.5% and specificity per patient of 59.1%. ECG had the highest sensitivity with LAD involvement LAD (37.3%) and RCA (25.8%), respectively. ECG had a probability of indicating coronary vessel disease in persons with the disease (positive predictive value) 71%, whereas, negative ECG findings were less likely to indicate the absence of disease (a negative predictive value = 46.4%. Similarly, ECG correctly classifying patients as having LAD, RCA, and LCx diseases (66.7%, 70%, and 66.7% respectively) as compared to its ability to correctly classify persons without the respective vessel disease (33.3%, 55.6%, and 55.6%). Among the patients, 59.3% were correctly identified

Conclusions: ECG has low sensitivity and specificity for predicting coronary artery stenosis with accuracy ranged 59.5% and 59.1% based on coronary artery analysis.

Introduction

Early diagnosis of coronary artery disease is mainly based on some risk stratification approaches. This includes medical history, physical examination, electrocardiogram and serum cardiac marker measurements [1,2]. The diagnosis requires a careful review of cardiac ischemia manifestations. Coronary artery disease (CAD) is a life-threatening condition that necessitates rapid decision-making [1,2].

Coronary angiography (CAG) is a useful diagnostic tool in patients with suspected CAD especially in patients that are at high risk [4-6]. CAG is the gold standard for diagnosis of significant coronary stenosis. However, it can be associated with certain risks [6].

The use of noninvasive assessment tools for predicting CAD is considered because it offers safety, patient convenience, and faster performance. The aim of the study was to assess the predictive value of 12-lead electrocardiogram (ECG) in patients with suspected coronary artery disease (CAD) [1].

Methods

Patients between 40 and 98 years of age who presented with new onset chest pain were recruited. They all had standard 12 lead

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electrocardiogram done. The ECG changes were interpreted by the two cardiologists.

The ECG was recorded as normal or abnormal depending on:

Regional changes in ST segment (ischemic-appearing ST depression or elevation)

T-wave inversion (≥ 1 mm) and Q-wave appearance (≥ 0.04 s or ≥ 25% of R-wave.

On admission, a resting standard 12-lead ECG was recorded and the ECG changes were interpreted by the cardiologist. The ECG was recorded as normal or abnormal depending on regional changes in ST segment. The ECG was recorded as normal or abnormal depending on regional changes in ST segment (ischemic-appearing ST depression or elevation), T-wave inversion (≥ 1 mm) and Q-wave appearance (≥ 0.04 s or ≥ 25% of R-wave).

The III, aVF and II leads were used to detect RCA involvement; V5, V6, lead 1 and aVL to detect LCx involvement, and V1, V2 or V3, and V4 were used to detect LAD involvement. ECGs were taken at a paper speed of 25 mm/s and calibration of 10 mm. All enrolled participants had coronary angiography using the femoral artery. Patients with a stenosis ≥ 50% diameter, were classified as having significant CAD.

We excluded patients with other severe concomitant diseases and patients previous bypass surgery. Also excluded are those with positive troponin and chronic kidney disease. Ethical approval was obtained from the hospital. An informed consent was also obtained from all participants. Approval was given by the ethical committee of the hospital and informed consents were obtained from all participants.

Quantitative data was presented as Mean ± standard deviations or percentages. Descriptive statistics including sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) of ECG in determining significant coronary artery stenosis were calculated. Predictive values of ECG between the two genders were compared using chi-square test. Statistical analyses for these parameters were performed by an independent statistician, using SPSS version 25 (SPSS Inc., Chicago, IL, USA).

Results

A total of 59 patients were recruited for the study over a 12-month period. The mean age is 61.2 ± 14. Of the coronary angiography reports, 37 out of 59 participants had significant coronary artery stenosis, with a prevalence of significant CAD was 62.7%. The coronary angiography did not detect significant stenosis in 22 of the patients (37.3%). ECG correctly detected significant stenosis in 21 patients out of the 59. It brings the overall sensitivity per patient was 64.9% and specificity of 68.2%. (see Tables 1-3)

Table 1. *Comparing Electrocardiography and Coronary Angiogram positive and cases*

	Positive Angiogram		Negative Angiogram	
ECG	Male	Female	Male	Female
Overall				
Positive	13	9	5	4
Negative	9	6	7	6
LAD				
Positive	7	5	5	3
Negative	3	3	2	2
RCA				
Positive	4	3	2	2
Negative	2	1	3	2
LCx				
Positive	2	2	1	1
Negative	1	1	1	1

RCA, right coronary artery; LCx, left circumference; ECG, electrocardiogram.

Table 2. *Predictive power of electrocardiogram for the diagnosis of coronary artery disease in comparison with coronary angiography.*

Artery	Sensitivity	Specificity	PPV	NPV	Accuracy
Overall	59.5	59.1	71.0	46.4	59.3
LAD	60.0	40.0	66.7	33.3	60.0
RCA	63.6	62.5	70.0	55.6	57.9
LCx	66.7	50.0	66.7	50.0	53.0

PPV, positive predictive value; NPV, negative predictive value; RCA, right coronary artery; LCx, left circumference; ECG, electrocardiogram; LAD, left anterior descending artery.

Table 3. *Predictive power of electrocardiogram for the diagnosis of coronary artery disease in comparison with coronary angiogram in men and women*

Artery	Sensitivity	Specificity	PPV	NPV	Accuracy
Overall					
Males	59.0	58.3	72.0	43.8	58.9
Females	60.0	60.0	69.2	50.0	40.0
p-value	1.000	.886	.757	.479	.011*
LAD					
Males	70.0	28.6	58.3	40.0	52.9
Females	62.5	40.0	62.5	40.0	53.8
p-value	.369	.137	.563	1.000	1.000
RCA					
Males	60.0	60.0	60.0	60.0	63.0
Females	75.0	50.0	60.0	60.0	62.5
p-value	.034*	.201	1.000	1.000	1.000
LCx					
Males	60.0	50.0	60.0	50.0	60.0
Females	60.0	50.0	60.0	50.0	60.0
p-value	1.000	1.000	1.000	1.000	1.000

LAD, left anterior descending artery; LCx, left circumference artery; RCA, right coronary artery

ECG correctly detected significant stenosis in 21 out of 59 patients. The overall sensitivity per patient was 59.5% and specificity of 59.1% (Table 2). ECG Sensitivity and specificity for LAD (60.0% and 40.0% respectively) (Table 2). ECG sensitivity and specificity for RCA (63.6% and 62.5% respectively) (Table 2). ECG sensitivity and specificity for LCx (66.7% and 50.0% respectively) (Table 2). Over ECG positive predictive value is 71.0% [probability of indicating coronary vessel disease in persons with the disease]. Over ECG negative predictive value is 46.4% [probability of negative findings that is less likely to indicate the absence of disease] (see Table 2).

Predictive power of electrocardiogram for the diagnosis of coronary artery disease comparison with coronary angiogram in men and women is shown in Table 3. There is no difference in the ECG capability in the diagnosis of coronary artery disease among men and women as there is no statistically difference in sensitivity and specificity with p-values of 1.000 and 0.866 respectively (See Table 3).

The figure 1 showed the distribution of ST segment, T-wave and Q-wave changes. ST-segment changes are more with Left Anterior Descending Artery [LAD], followed with Right Coronary Artery [RCA] and then the Left Circumference artery [LCx]. Q-wave changes are more with LAD, followed with LCx and then RCA (see Figure 1).

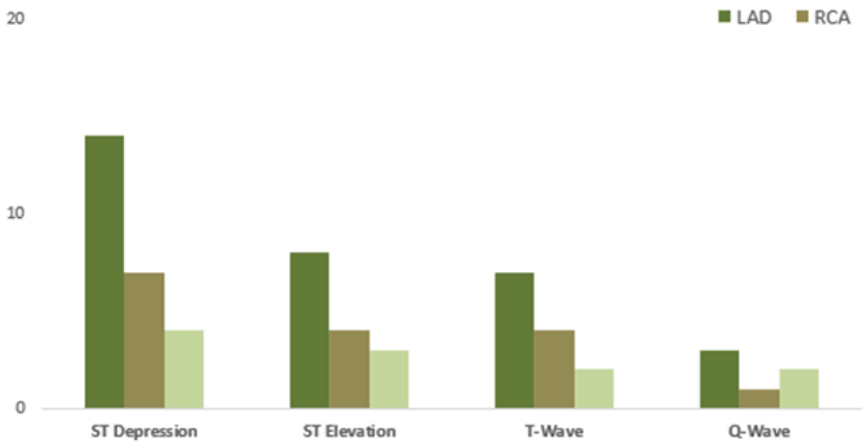

Figure 1. *ST-segment changes, T-wave change and Q-wave.*

Discussion

12 lead ECG has been known as an important routine part of the assessment of patient presenting with chest pain.[7] electrocardiography is an integral part of patient evaluation for suspected coronary artery disease.[1] Among the patients with chest pain, the prompt and accurate detection of acute coronary syndrome remains an important clinical challenge for specialists.[7]. This is what the pilot study showed. First, our study showed that electrocardiography is safe, non-invasive and easily available tool to be used in the emergency room in detecting patients with chest pain suspected coronary artery.

There are studies that focused on cost-beneficial aspect and feasibility of this tool, and on its prognostic and predictive values. [8, 9,10, 11] Our study showed that electrocardiography is valuable in the emergency room. Mahmoodzadeh et al in a study of electrocardiography, correctly detected significant stenosis in 176 out of 400 patients with an overall sensitivity per patient of 51.5% and specificity per patient of 66.1%. [12] Of the 59 patients in the present study, the sensitivity and specificity are 59.5% and 59.1% respectively. The current study had similar sensitivity and specificity even when our study had fewer number of patients.

Somani and his colleagues in a study of correlation of electrocardiography Changes with Coronary Angiographic Findings in Patients of Coronary Artery Disease, involved 200 participants. Their study showed a sensitivity and specificity of electrocardiography to diagnose myocardial infarction or ischemia ranged from 87.50% to 96.63% and 91.30% to 95.45%, respectively.[13] Their study also showed diagnostic accuracy of electrocardiography to detect myocardial infarction or ischemia, ranged from 89.36% to 96.40%. these findings were higher than the present study. The possible reasons could be due to race difference, and the prevalence of the disease from the former study.

Based on the present findings, each electrocardiography parameters independently could poorly predict coronary artery disease with very low sensitivity. But, when considered together, predictive power was significantly increased. Similarly, Holubkov and colleagues showed that using at least two electrocardiography parameters in any set of contiguous leads cause notable higher odds of significant angiographic coronary artery disease than those without concomitant ECG parameters changes. [14] furthermore, the judgment about the presence of coronary artery disease should be performed on the sum of electrocardiography parameters findings.

Electrocardiography has been well known as an attractive method for patients' risk stratification. [15] Recent studies found that the changes in electrocardiography parameters such as ST-segment depression and T-wave inversion could effectively predict long term mortality and morbidity of patients with acute coronary syndrome and also those who undergoing cardiac revascularization.15, 16] Despite poor value of electrocardiography to predict appearance of sudden cardiac attack, it may be potentially useful for predicting late outcome of cardiac diseases in comparison with invasive strategies that should be strongly considered.

Conclusion

ECG is useful in risk stratification of patients with CAD. It is valuable in the diagnosis of CAD especially in resource poor settings..

Limitation

This is a pilot study with small sample size..

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