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The Association between Myocardial Perfusion Scan and Electrocardiographic Findings among Patients with Myocardial Ischemia

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Abstract

Introduction: The aim of this study was to determine the consistency of Electrocardiography (ECG) and myocardial perfusion scan findings of patients with myocardial ischemia at Firoozgar and Hazrat-Rasool hospitals.

Methods: Electrocardiogram of 80 patients undergoing myocardial perfusion scans was analyzed. All patients had a stable angina. All patients with bundle branch blocks and history of MI and coronary bypass or angiography were excluded. Overall, 120 patients were evaluated with single photon emission tomography/myocardial perfusion imaging for ischemia and 80 patients had a positive test.

Results: Forty-five percent of patients were female and 55% were male. The average age of patients was 61.48 years. Sixty-one patients (76.25%) had normal ECG and 19 patients (23.75) had pathological changes in their ECG. Eleven patients had ST segment depression and 6 patients had T wave inversion. Furthermore, 21 patients (26.25%) had lateral wall ischemia in their myocardial perfusion scan and 13 (16.25%) patients had septal wall ischemia. The ECG changes in male patients and hypertensive cases were more prominent.

Conclusions: This study showed that ST-T changes (ST depression and T inversion) in the ECG are more suggestive of accuracy of myocardial ischemia and ECG.

INTRODUCTION

Coronary Artery Disease (CAD) is one of the most important leading causes of death in almost all communities. Myocardial Infarction (MI) is one of CAD manifestations and can be detected by a cardiologist as the first manifestation [1]. Recognition of Myocardial Infarction (MI) is by clinical manifestations, such as Electrocardiographic (ECG) findings, alteration in values of myocardial cell-specific biomarkers, which are released in plasma after necrosis and different imaging methods [1]. Single Photon Emission Tomography/Myocardial Perfusion Imaging (SPECT/MPI) has become the cornerstone of the follow up imaging method in patients with suspected CAD and proved CAD. Furthermore, SPECT/MPI is used for detection of myocardial perfusion defects after stress exertion, which can determine the suitable management approach and can help in classification of patients according to their risk [2].

Cardiac electrical activity produces a current through the body, which can be recorded on the surface of the body by an electrocardiogram as an Electrocardiography (ECG). At first, ECG records were only able to show the electrical activity in the vertical plane by defining the difference in the voltage between arms and the left leg known as the limb system. With further developments, the precordial unipolar lead system was added to the limb system, and provides information about cardiac electrical activities in the horizontal plane [3, 4]. The augmented unipolar limb leads aVR,

aVL, and aVF, use one of the limb electrodes as their positive pole and combination of inputs from other two limb electrodes (Goldberger's central terminal) as negative pole [5]. The combination of these three systems resulted in a 12-lead ECG, which became one of the standard non-invasive diagnostic tools in the medical fiel [6]. Electrocardiographic findings, such as ST segment depressions, inverted T waves, and pathological Q waves are some of the ECG uses for diagnosis of ischemia [7, 8]. There are limitations in the use of ECG in patients with CAD, especially in stable and asymptomatic patients. Moreover, in patients with acute coronary syndrome, ECG has a high diagnostic accuracy only for non-ST segment elevation MI [9]. The aim of this study was to determine the correlation of SPECT/MPI and ECG findings and compare the accuracy of these two diagnostic methods.

METHODS

The study population comprised of patients, who underwent myocardial perfusion scan at Firouzgar and Hazrat-e-Rasool hospitals in 2015. After obtaining approval from the ethics committee and written consent of the patients, all of the collected information was analyzed confidentially. The Helsinki ethical principles were considered for all the people in the project. Patients, who underwent myocardial scan perfusion in these two hospitals and their report resulted in myocardial ischemia, were included in this study and their ECGs were assessed. Patients with a presence of artifact in their ECG or perfusion scan or past medical history of coronary bypass surgery, bundle branch block, angioplasty, and myocardial infarction were excluded from the study. Moreover, the demographic and history of the cardiovascular disease risk factors were included in the checklist. Sampling was continued until the required sample size was reached. After determination of the study sample size, the information of the perfusion scan and ECG reports in addition to patients' records were included in the checklist. Changes in the ECG records were matched with the involved cardiac wall in the perfusion scan. Due to the study variables, the required data were extracted by the researcher from the patients' records and perfusion scan and the ECG report available in the archive of the hospitals and included in the checklist, which was designed for this purpose. In case of incomplete patients' records, data were collected by contacting the patient by phone.

Statistics

The perfusion scan sensitivity and specificity was calculated as 84.2% and 78.7%, respectively, in females, and 89.1% and 71.2% in males, and the prevalence of CAD was 6.5% [10]. The sample size was calculated as 94 subjects in each group considering $\alpha = 5\%$. All data were presented as mean ± SD for quantitative variables and were summarized by frequency (percentage) for categorical variables.

RESULTS

A total of 120 patients were studied in this research, which was intended for assessing the correlation between SPECT/MPI results and ECG results in Firoozgar and Hazrat-e-Rasool hospitals, Tehran, Iran. Eighty of 120 patients had positive SPECT/MPI results and their ECG results were then observed. Furthermore, 45% of patients were female and 55% were male. Average age of patients was 61.48 ± 12.43 years old. The average age of males was 59.07 ± 14.41 years and for females this was 64.20 ± 12.43 years. Average Body Mass Index (BMI) was 24.41 ± 3.48 kg/m^2, and 29.2% of patients were smokers and 10.8% had a history of smoking. Sixty percent had no history of smoking. Forty-five percent of involved patients had diabetes, 65% had hypertension, 24% had dyslipidemia, and 19% had a history of CAD (Table 1).

Table 1: Patient Characteristics

N = 80	
Male	44 (55%)
Age (years), Mean ± SD	61.48±12.43
History of smoking	32 (40%)
Diabetes	36 (45%)
Hypertension	52 (65%)
Dyslipidemia	19 (24%)
history of coronary artery disease	15 (19%)
BMI (kg/m^2), Mean ± SD	24.41 ± 3.48
Abnormal ECG	19 (23.7%)

Ninety of 80 patients with positive SPECT/MPI had ECG changes. All the patients with negative SPECT/MPI had normal ECG. Therefore, the sensitivity, specificity, and negative and positive predictive value of ECG for detection of CAD were 23.5%, 100%, 100% and 39.6%, respectively. The most involved walls of the heart were lateral and septal walls, according to the SPECT/MPI results (Table 2), and the most ECG changes were ST-depression (Tables 3 and 4) There was no correlation between site of ischemia in SPECT/MPI and involved leads in ECG.

Table 2: Abundance of Single Photon Emission Tomography/ Myocardial Perfusion Imaging Changes According to their Involved Walls and Intensity of Ischemia

Wall Type	Sever	Moderate	Mild
Anterior wall (n=6)	-	-	6
Lateral wall (n=21)	-	-	21
Septal wall (n=13)	-	-	13
Inferior wall (n=3)	-	-	3
Posterior wall (n=0)	-	-	-
Anterior+ lateral wall (n=6)	-	-	6
Anterior + septal wall (n=18)	-	-	18
Lateral+septal wall (5 patients)	-	-	5
Anterior+lateral+inferior wall (n=3)	3	-	-
Lateral+septal+inferior wall(n=5)	-	-	5

Table 3: Abundance of Electrocardiography Changes According to Leads in Patients with Positive Single Photon Emission Tomography/Myocardial Perfusion Imaging

Lead	Leads' involvement	Male	Female	Diabetes	Smoking	Dyslipidemia	CAD history	Hypertension
ST-elevation (2 patients)								
aVR	-	-	-	-	-	-	-	-
V5,V6	-	-	-	-	-	-	-	-
V1,V2 or V3 and V4	2	1	1	1	2	2	1	1
I,AVL	-	-	-	-	-	-	-	-
II,III,aVF	-	-	-	-	-	-	-	-
ST-depression (11 patients)								
aVR	-	-	-	-	-	-	-	-
V5,V6	-	-	-	-	-	-	-	-
V1,V2 or V3 and V4	4	2	2	1	2	2	2	2
I,AVL	3	2	1	2	2	2	1	2
II,III,aVF	4	4	-	-	1	2	2	2
T inversion (6 patients)								
aVR	-	-	-	-	-	-	-	-
V5,V6	1	1	-	-	1	1	-	-
V1,V2 or V3 and V4	-	-	-	-	-	-	-	-
I,AVL	3	2	1	1	2	1	3	3
II,III,aVF	2	2	-	2	1	1	1	1
Abnormal Q wave(0 patient)								
aVR	-	-	-	-	-	-	-	-
V5,V6	-	-	-	-	-	-	-	-
V1,V2 or V3 and V4	-	-	-	-	-	-	-	-
I,AVL	-	-	-	-	-	-	-	-
II,III,aVF	-	-	-	-	-	-	-	-
Total patients (%)		14(74)	5(26%)	7(37%)	11(58%)	11(58%)	10(53%)	11(58%)

Table 4: Abundance of Types of Electrocardiography Changes According to Involved Heart Wall in Single Photon Emission Tomography/Myocardial Perfusion Imaging

Involved wall Leads	Anterior Lead	Lateral Lead	Septal Lead	Inferior Lead
ST-elevation				
aVR	-	-	-	-
V5,V6	-	-	-	-
V1,V2 or V3, V4	1	1	1	-
I,AVL	-	-	-	-
II,III,AVF	-	-	-	-
ST-depression				
aVR	-	-	-	-
V5,V6	-	-	-	-
V1,V2 or V3, V4	3	4	-	-
I,AVL	3	-	3	-
II,III,AVF	4	-	5	-
T wave inversion				
aVR	-	-	-	-
V5,V6	-	1	1	1
V1,V2 or V3, V4	-	-	-	-
I,AVL	2	1	3	1
II,III,AVF	2	2	-	-
Abnormal Q wave				
aVR	-	-	-	-
V5,V6	-	-	-	-
V1,V2 or V3, V4	-	-	-	-
I,AVL	-	-	-	-
II,III,AVF	-	-	-	-

DISCUSSION

Precise non-invasive study of ischemia existence and its extent, and Coronary Arteries Disease (CAD) intensity can be beneficial for avoidance of invasive actions and angiography. As a result myocardial perfusion scan instantly after chest pain initiation in patients with CAD risk factors is recommended [11]. Furthermore, SPECT/MPI is an accepted method for determination of treatment and intervention in addition to its predictive value [2]. In previous studies, it was shown that the most common changes in ECG of patients with chronic CAD, are changes in T and ST segments. Amount of these changes is relevant to severity of patients' cardiac diseases history. Also, normal and long-term changeless ECG is the best predictor of these patients' prognosis. In addition, existence of left ventricle hypertrophy in ECG is an indicator for poor prognosis in patients with CAD. Because of this, further evaluations are recommended in patients with hypertension and signs of left ventricle hypertrophy [12].

In a similar study on 257 patients with proven CAD by Farham et al., patients' ECG was evaluated for ST segment and T wave changes in AVL lead. They showed that ST-T segment changes in AVL lead and mid segment of LAD involvement are consistent [13]. The study of Kang et al. showed that maximum ST-segment depression doesn't show the site of perfusion defect. However, ST-segment elevation during exercise, which occurs occasionally, predicts myocardial ischemia site [14]. Regarding the results of the present study, most changes observed in the patients' ECG with the presence of perfusion scan involvement was ST-segment depression and then T wave inversion. Given that our study patients were with stable angina, this result was expectable. Also, the most involved area in perfusion scan results was lateral and septal wall. Saitoh et al. carried out a study to diagnose CAD with 12 lead ECG simultaneously with myocardial perfusion scan in patients with unstable angina. The results showed that in diagnosis of CAD, ischemic changes in the ECG during angina attack have high sensitivity and low specificity while, abnormal perfusion scan, has low sensitivity and high specificity. Therefore, they claimed that both the 12-lead ECG and perfusion scan are helpful in diagnosis of CAD in patients with unstable angina [15]. A report by Weber et al. on 341 patients showed that ST-T segment changes in ECG has an important role in diagnosis of cardiac ischemic disease. The sensitivity of ECG for diagnosis of myocardial ischemia in females was higher than males, and its specificity was higher in males [16]. According to this study and other similar studies, in patients with myocardial ischemia, ECG findings could be normal and this might suggest the need for complementary investigations. Also, the importance of the ST-segment and T wave changes in ECGs of patients with cardiac disease is more emphasized than ever. Results of this study showed a significant difference between genders.

This study showed that ST-T changes (ST depression and T inversion) in the ECG are more suggestive of accuracy of myocardial ischemia.

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