Accuracy of Treadmill Test in Diagnosis of Ischemic Heart Disease in Correlation with Coronary Angiography

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Received: May 01, 2019; Accepted: May 14, 2019; Published: May 21, 2019

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Abstract

Background: Treadmill test is an important non-invasive investigation in diagnosis of suspected cases of ischemic heart diseases. In this test, we try to examine the heart under increasing load especially if the resting electrocardiography is normal or non-diagnostic.

Objectives: To find the specificity and sensitivity of Treadmill test in diagnosis of ischemic heart diseases.

Patients and Methods: Fifty patients who had chest pain underwent exercise tolerance test and advised to do coronary angiography. They were divided into four groups according to the results of treadmill test and coronary angiography.

Results: During this study (50) patients (31 males and 19 females) presented with chest pain underwent treadmill test and coronary angiography all the patients were included in the study. The mean age of patients was 57.3 ± 3 years, true positive group included 46 patients while the other groups false positive groups, true negative, and false negative included two, one and one patient respectively. The sensitivity of treadmill test was 97.7% and specificity was 33.3%.

Conclusion: Treadmill test is useful test for diagnosis of chest pain because it’s sensitive, non-invasive and cost effective.

Keywords: Treadmill test; IHD; Coronary angiography

Abbreviations: ECG: Electrocardiography; TMT: Treadmill Test; EET: Exercise Electrocardiogram Treadmill; CAG: Coronary Angiography; TP: True Positive; TN: True Negative; FP: False Positive; FN: False Negative; HR: Heart Rate; HTN: Hypertension; DM: Diabetes Mellitus; CAD: Coronary Artery Diseases

Introduction

A cardiac stress test is a diagnostic test used in cardiology in which the ability of the heart to response to stress either physically or pharmacologically is measured in controlled clinical setting [1]. This inexpensive test is mainly used to elicit the likelihood and extent of myocardial ischemia indirectly [2]. Cardiac stress test attempts to compare coronary circulation at the rest with observer near maximal physical exertion induced imbalance of blood flow to myocardium. The result may also be interpretive as a reflection on a person’s over all physical fitness, these are typically included in initial evaluation of patient with suspected ischemic heart disease and as a prognostic indicator after myocardial infarction [3]. Treadmill test is an important investigation not only in patient with suspected CAD but also in established CAD, in former group it helps us to exclude CAD in patient with chest pain and in latter group used to assess functional capacity, risk stratification and to predict prognosis. Stress test is physiological test, has a great advantage of assessing the adequacy of myocardial blood flow without even knowing the coronary anatomy, while coronary angiography (CAG) has non-physiological value in spite of excellent assessment of coronary anatomy [4]. Numerous studies have validated that even in asymptomatic population an ischemic ST segment response to exercise is a risk factor for future development of coronary events (e.g. angina pectoris, myocardial infarction, sudden death) [5].

EET is less specific in patients with some metabolic conditions (anemia, glucose load, hyperventilation, and hypokalemia), some structural heart diseases (severe aortic stenosis, mitral valve prolapsed, severe aortic or mitral regurgitation, cardiomyopathies, and left ventricular hypertrophy), marked resting ST segment depression, intra-ventricular conduction disturbances, pre-excitation syndromes, severe hypertension, severe hypoxia, sudden excessive exercise, supraventricular arrhythmias or digitalis therapy [6].

In addition, the pattern of coronary artery disease would also affect the specificity and sensitivity of the test. In patients who underwent coronary angiography, EET sensitivity is approximately 68% and specificity is 77%. The sensitivity for those with single vessel disease varies from 25% to 71% with the involved vessel, being most sensitive to lesion in the left anterior descending coronary artery, followed by abnormalities in the right coronary artery and the least sensitivity is noticed in patients suffering from isolated lesions of left circumflex coronary artery. These figures for patients with multivessel CAD are 81% sensitivity and 66% specificity. This may rise to 86% and 53%, respectively for the patients with left main or three-vessel coronary artery disease [7]. Finally, according to Bayes’ theorem, the specificity
and sensitivity of the test is affected by the baseline frequency of the disease in the studied population (pretest probability) [6] (Figures 1 and 2).

The treadmill protocol should be consistent with the patient's physical capacity and the purpose of the test. The modified Bruce protocol include 3-minute warm up stages at 1.7 mph and 0 percent grade and 1.7 mph and 5 percent grade [8]. It is commonly thought that false negative exercise ECG also occurs with failure to reach an adequate peak heart rate on exercise, often due to administration of a beta blocking or calcium channel blocking medication [9,10].

A coronary catheterization is a minimally invasive procedure to access the coronary circulation and blood-filled chambers of the heart using a catheter. It is performed for both diagnostic and therapeutic purposes [11]. Coronary catheterization is one of the several cardiology diagnostic tests and procedures [12,13]. Important internal heart and lung blood pressures, not measurable from outside the body, can be accurately measured during the test [14].

However, it has been increasingly recognized, since the late 1980's, that coronary catheterization does not allow the recognition of the presence or absence of coronary atherosclerosis itself, but only significant luminal changes which have occurred as a result of end stage complications of the atherosclerotic process [15].

Patients and Methods

A cross sectional study was conducted at Sulaimania center for heart diseases from the period of January 2014 to August 2014. Fifty patients included in this study, 31 males and 19 females with mean age of 57.30 years, all of them underwent (TMT) for the diagnoses of ischemic heart diseases (IHD) were advised to do CAG and all the patients were included in this study. The patients were divided into four groups depending on the results of TMT and coronary angiography; i.e., true positive, true negative, false positive and false negative. The resting ECG and TMT done and interpreted according to modified Bruce protocol.

Inclusion criteria

Patient with chest pain with normal or abnormal ECG are included, who had single or multiple risk factors like hypertension, diabetes, smoking and other risk factors.

Exclusion criteria

1. Valvular heart diseases or valve surgery.
2. Recent myocardial infarction.
3. Patient on treatment like digoxin.
4. History of angioplasty.

Statistical Analysis

The results are analyzed by using (statistical package for social sciences) version 16. Descriptive study used to calculate of frequency, percentage and correlation for nominal data. A p value of <0.05 was consider significant.

Results

During the study period a total of 50 patients presenting with chest pain underwent TMT. All patients had been advised to undergo coronary angiography, 31 males (62%) and 19 females (38%) patients were included in this study. The mean age of study population was 57.30 years. Mean age for true positive group was 57.2 years, while it was 54.4 years in false positive group. The true positive group included 28 patient’s males and 18 females, the false positive group included two patients (one male and one female), while the true negative and false negative each include only a male patient. The conventional risk factors like hypertension, diabetes mellitus, smoking, had close difference between the groups Table 1.

<table>
<thead>
<tr>
<th>Variables</th>
<th>TP</th>
<th>FP</th>
<th>TN</th>
<th>FN</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean age (years)</td>
<td>57.2</td>
<td>54.4</td>
<td>63</td>
<td>61</td>
</tr>
<tr>
<td>Male</td>
<td>28</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Female</td>
<td>18</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DM</td>
<td>15</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>HTN</td>
<td>19</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Smoking</td>
<td>15</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Table 1: Epidemiological characteristics of the study.

The resting 12 leads ECG were normal in 37 patients (74%) and abnormal in 13 patients (26%). In true positive group (33) patients had normal ECG and (13) patients had abnormal ECG, while in false positive group two patients had normal ECG. The ECG was normal in both true negative and false negative group. Coronary angiography revealed that 21 patients (42%) patients had single vessel disease, 19 patients (38%) had two-vessel disease and 7 patients (14%) had three-vessel disease. Among the single vessel disease, (13) patients had left anterior descending artery disease, two patients had LMS, five patients had right coronary artery disease and one patient had LCX (Table 2), the mortality during procedure was zero.

<table>
<thead>
<tr>
<th>Diseased vessels on CAG</th>
<th>TP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single</td>
<td>21</td>
</tr>
<tr>
<td>LMS</td>
<td>2</td>
</tr>
<tr>
<td>LAD</td>
<td>13</td>
</tr>
<tr>
<td>LCX</td>
<td>1</td>
</tr>
<tr>
<td>RCA</td>
<td>5</td>
</tr>
<tr>
<td>Two</td>
<td>19</td>
</tr>
<tr>
<td>Three</td>
<td>7</td>
</tr>
</tbody>
</table>

Table 2: Numbers and types of the affected vessels.

The partial correlation controlled for age show strong positive correlation between TMT results and CAG findings (C=0.306, p=0.033), which is only significant among correlations of TMT with other variables as shown in Table 3.
Table 3: Age controlled partial correlation of TMT and CAG findings.
Limitations of Study

The study has few limitations:

1. The study population was very small as we had only 50 patients.
2. Because coronary angiography is invasive procedure and has cost effect to our population and if a patient is not severely symptomatic could not be compelled to go for this test.

Conclusion

Despite of wide variability of sensitivity and specificity of treadmill test, this test still is useful for the evaluation of chest pain because of its simplicity and its cost-effectiveness. It is one of the non-invasive tests that help in diagnosis of CAD especially patients with chest pain and normal ECG. There is significant correlation between TMT results and CAG findings.

Conflicts of Interest

There are no conflicts of interest for the present study.

References