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

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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 57.30 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 asses 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, supra-ventricular 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 1.7mph 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.

Variables	TP	FP	TN	FN
Mean age (years)	57.2	54.4	63	61
Male	28	1	1	1
Female	18	1		
DM	15	0	0	0
HTN	19	0	0	0
Smoking	15	1	0	0

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.

Diseased vessels on CAG	TP		
Single	21	LMS	2
		LAD	13
		LCX	1
		RCA	5
Two	19		
Three	7		

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.

Control Variables			CATH	HTN	Gender	DM	Smoking	ECG
Age	TMT	Correlation	0.306	0.231	0.231	0.196	0.119	0.091
		p value	0.033	0.11	0.11	0.177	0.414	0.534
		Degree of freedom	47	47	47	47	47	47

Table 3: Age controlled partial correlation of TMT and CAG findings.

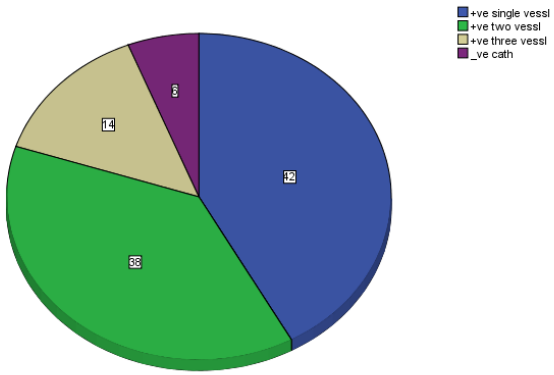

Figure 1: The number and percentage of diseased vessels lesion by CAG.

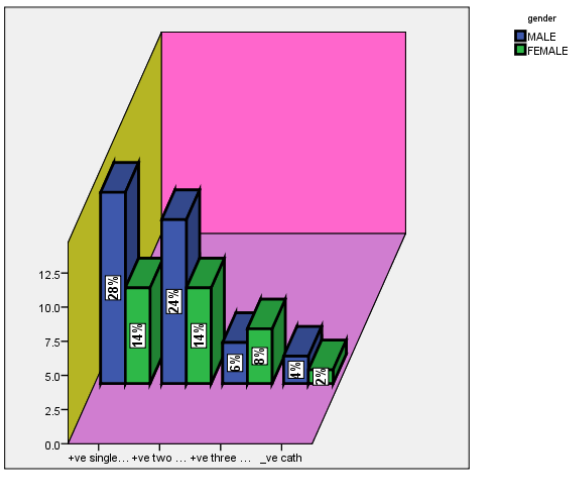

Figure 2: Percentage and number of diseased vessels in comparison with gender.

Discussion

TMT is used as non-invasive indicator for presence or absence of CAD in patients complaining of chest pain. Chest pain combined with ST-segment depression had a much higher accuracy rate than ST-segment depression alone [16]. In current study the sensitivity of TMT (ability to recognize significant CAD when it was present) was 97.7% and the specificity (ability to exclude any CAD when it was absent) was 33.3% as compared to result of study done by CDR. Allend, Johnson et al. [17-19] the sensitivity was 80.4% and specificity was 88.4% this deference is because we have only 50 patients as compare with other study, this means that a positive TMT result is more indicative of disease than a negative TMT result is for the absence of disease in patient complaining of chest pain.

The predictive value of positive test which is =TP/(TP+FP) × 100 in our study is =95, 83%. The predictive value of negative test which is =TN/(TN+FN) × 100% in our study is =50%, this result is similar to result done by Kelemen MH [19] at which predictive value for positive and negative test was 96% and 51% respectively. The efficiency of the test which is equal to (TP+TN)/ (TP+FP+TN+FN) × 100 in our study is 94% which is equal to result done by Vieweg et al. the efficiency was 95% [19]. In current study the number of male patients is more than female patients in true positive group while they are equal for false positive group, the percentage of male patient is 60.7% and female 39.3% in true positive, and it is 50% for male and female in false positive group. In comparison with the result of study done by Abdul Wajid at Punjab, Lahore [20] percentage of male patients is 93.7% and female was 6.3% for true positive group, while in false positive group, percentage of male was 63% and female was 36%. In a meta-analysis evaluating ECG testing for women, sensitivity and specificity were 61% and 70%, respectively [10]. In comparison, a meta-analysis in men showed a slightly higher sensitivity and specificity of 72% and 77%, respectively [21], these differences because we had small number of populations in our study.

The number of vessel lesions demonstrated that most common lesion is single vessel about 42%, while second common vessel is two vessel about 38%, and three vessel disease is about 14%, in correlation to study done by Abdul Wajid at Punjab institute, Lahore [20], as follow: single vessel 27%, two vessel 32% and three vessel 40%. It was observed that the most frequent coronary artery involved was LAD followed by RCA. This has been reported previously by other investigations as well. Necropsy studies and cardiac computed tomography angiography (CCTA) have demonstrated the highest plaque and calcium deposit burden in the left anterior descending artery (LAD) followed by the right coronary artery (RCA), circumflex branch (CX) and left main stem (LM) [22-27].

Lastly female in our study appear to have more wide spread ischemia then male, In a detailed analysis of women with suspected ischemic CHD enrolled in the Women's Ischemic Syndrome Evaluation (WISE), >50% had non-obstructive coronary artery disease (<50% stenosis), while the remaining had minimal to no detectable disease [28]. Similarly, women presenting with ST elevation myocardial infarction have higher rates of non-obstructive disease than men, 10-25% compared to 6-10% [29]. In the current study there is significant correlation between TMT results and CAG findings (p=0.033) [30] but it does not show significant correlation with other variables (HTN, DM, smoking and ECG).

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.

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