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**Research Article**

# Role of treadmill stress testing in patients with coronary risk factors

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## ABSTRACT

**Background:** Stress testing is a simple, reliable and excellent non-invasive method for diagnosing coronary artery disease in asymptomatic patient and predicting future coronary events, particularly in patient with coronary risk factors. A risk factor is a feature of individual or population that is present early in life and is associated with increased risk of developing disease in future. Risk factor of interest for coronary artery disease may be hypertension, diabetes mellitus, smoking, hyperlipidaemia, obesity and physical inactivity.
**Methods:** A clinical survey of 50 cases of patient with coronary risk factor was carried out at Civil Hospital, Ahmedabad. These patients were subjected to tread mill stress testing after proper preparation.
**Results:** In the present study modifiable risk factors like hypertension have 81% positive test; diabetics with hypertension have 91% positive test; smokers have 80% positive test; obese patients have 67% positive test and those with physical inactivity have 78.12% positive test.
**Conclusions:** Most patients with modifiable risk factors are unaware of their condition and Coronary Artery Disease can be reduced efficiently if these patients are made aware of the risk and proper action is taken to control the risk factors.

**Keywords:** Coronary risk factors, Treadmill stress testing

## INTRODUCTION

It was observed in majority of patients under high risk for Ischemic Heart Disease that they were unaware of their health condition. Even with complaints of chest pain, breathlessness and uneasiness, the patients were careless about their health.

From epidemiological perspective, a "risk factor" is a feature of individual or population that is present early in the life and is associated with increased risk of developing disease in the future. Risk factors of interest for ischemic heart disease may be hypertension, diabetes mellitus, smoking, hyperlipidemia, obesity, and physical inactivity.[1]

During extensive work in the field of ischemic heart, it was accidentally noted that ST segment changes occur in the Electrocardiogram leads during exercise in the patients with a history of angina.[2] Bruce (in 1956 A.D.) reported a stress test performed as treadmill and later in 1957 A.D., he used a computer to analyze exercise stress testing. Stress testing is a simple, reliable and excellent non-invasive method for diagnosing Coronary Artery Disease in asymptomatic patient and predicting future coronary events particularly in patient with coronary risk factors. The marks for ST-segment deviation and degree of angina are connected with a straight edge.[3]

Therefore, the treadmill stress test was performed on these patients for proper assessment and better prediction of health conditions of the patients. The test results and prognosis were discussed with the patients and they were

convinced to improve their lifestyle to avoid possible future occurrence of ischemic heart disease.

***Review of literature***

- Brousfield (In 1918 A.D.) recorded ST segment depression in 3 standard Electrocardiogram leads during anginal attack.[4]
- Field and Segal (In 1928 A.D.) noted ST segment depression during exercise of a patient, who was having history of coronary artery disease.[5]
- Goldhammer and Scherf (In 1932 A.D.) reported a stress test of the patient with H/o angina, in which 75 % of them developed ST segment depression. So, they proposed that exercise stress test is useful to confirm the diagnosis of angina.[6]

***Indications of TMT Test***

The most important indications for stress testing are:

1. Adult patient with intermediate pre-test probability of Coronary Artery Disease.
2. Known or suspected case of Coronary Artery Disease for risk stratification.
3. After MI pre discharge, early discharge and late discharge to evaluate work capacity.
4. To demonstrate ischemia before revascularization.
5. To evaluate recurrent ischemia after revascularization.
6. To set rate adaptive pace maker.

***Contraindications of TMT Test***

1. Recent complicated myocardial infraction
2. Unstable angina
3. Uncontrolled ventricular arrhythmia
4. Uncontrolled atrial arrhythmia
5. 3rd degree A V block without pacemaker
6. Acute congestive cardiac failure
7. Severe aortic stenosis
8. Suspected aortic aneurysm
9. Active or suspected myocarditis, endocarditis or pericarditis
10. Intracardiac tumors
11. Recent pulmonary or systemic embolization

***Indications of termination of TMT Test***

*Absolute*

1. Onset of severe angina/increasing anginal pain/severe shortness of breath/CNS symptoms in form of vertigo, ataxia, visual or gait problem.
2. Sign of poor perfusion in form of pallor, cyanosis or cold extremities.
3. Drop in systolic BP with exercise.
4. Acute MI or suspicion of MI.
5. Serious arrhythmias such as 2nd and 3rd degree heart block, sustained VT, AF with VR.
6. Patient's request.

*Relative*

1. Any chest pain that is increasing in severity
2. Wheezing
3. Leg cramps or intermittent claudication
4. Systolic BP > 260 or Diastolic BP > 115
5. > 22 mm ST segment elevation or depression
6. Exercise induced bundle branch block

***Role of Treadmill test***

*Diagnostic uses*

- Choice of test depends on it sensitivity and specificity. It depends on pretest probability of Coronary Artery Disease for patient.
- In general, sensitivity is 25-81 %. It is more in patient with LAD> RCA> LCX lesions.
- For TVD sensitivity is 81 % and specificity is 66 %

*Prognostic uses*

Asymptomatic patients:

- Prevalence of abnormal test in 5-12 %
- But only 25 % of patient show cardiac events in 5 years.
- Probability of a person with abnormal test to have cardiac events is 9 fold more than general population. It depends on presence of conventional coronary risk factors.

Symptomatic patients:

- TMT is done before angiography to see for functional significance of coronary artery stenosis of patient with suspected Coronary Artery Disease. If known patient of Coronary Artery Disease can perform 10 met ACT the diagnosis is good irrespective of stenosis at angiography.

***Treadmill score***

Treadmill Score = Exercise Time – (5 ST Deviation) – (4 Anginal Index)

ST deviation = Maximum net ST displacement in any lead

*Anginal index*

= 0 if no chest pain

= 1 if angina during exercise

= 2 if angina was the reason to stop exercise

***Patients with myocardial infarction***

- Usually we perform sub maximal stress test 3-5 days predischarge and standard treadmill test at 6 weeks.
- In sub maximal test, a patient should achieve at least 70 % of predicated heart rate or 5-6 met work load without development of angina or ST – T changes. This indicates better prognosis.
- 6-week test is useful for deciding work capacity in office and advice for cardiac rehabilitation.

***Patient with heart failure***

- Deceased work capacity in patient with CCF is indicator of skeletal muscle abnormality. It is associated with decreased oxygen consumption at peak exercise level and disproportional increase in ventilation at sub maximal exercise.

***Patient with cardiac rhythm and conduction abnormalities***

*VPC*

- In asymptomatic patient, presence of VPC during test does not increase the risk.
- In patient with history of MI, induced VPC are associated with increased cardiac adverse events.
- Among victims of 25-50 % of sudden deaths exercise induced repetitive VPCs are present.
- Beta blockers decrease exercise induced VPC.

*SVT*

- Prevalence in general population is 4-10 %
- In patients with underlying heart disease it is 40 %
- During exercise sustained SVT is seen in 1-2 % of patients with underlying heart disease.
- It is not diagnostic of coronary artery disease.

*AF*

- Exercise increase VR in patient with AF
- Control of VR does not increase capacity in patient with AF. It depends on underlying etiology.

*Sick sinus syndrome*

- Exercise lowers the HR at sub maximal and maximal work load. In 40% of patients, there can be normal response.

*LBBB*

- ST depression is found in most patients with LBBB. It is not of any significance.
- Mortality is 3 times higher in patients with LBBB.
- If ST segment depression occurs before appearance of LBBB or it recovers after LBBB, it still suggests abnormal response.

*RBBB*

- ST depression in V1 – V4 with RBBB is not abnormal
- If ST depression occurs in V5- V6 or II and AVF with decreased exercise capacity, then it is abnormal response.

***Coronary risk factors***

*Major risk factors*

- High LDL cholesterol
- Cigarette smoking
- Hypertension (BP ≥140/90 mmHg or on antihypertensive medication)
- Low HDL cholesterol (<1.0mmol/L [<40 mg/dL])
- Diabetes Mellitus
- Family History of premature CHD
- Age (Men ≥45 years; women ≥55 years)
- Lifestyle risk factors
- Obesity (BMI ≥ 30 kg/m2)
- Physical inactivity
- Atherogenic diet
- Emergency risk factors
- Lipoprotein (a)
- Prothrombotic factors
- Proinflammatory factors
- Impaired fasting glucose
- Subclinical atheroclerosis

*Minor risk factors*

- Hyperhomocystinemia
- Psychological factors
- Insulin Resistance syndrome
- Tissue type plasminogen activator (t-PA)
- LDL phenotype- B
- Hyperfibrinogenemia
- Anti phospholipid antibody syndrome
- Endothelial dysfunction
- Plasminogen activator inhibitor (PAI-1)

## METHODS

The most widely used test for both the diagnosis of ischemic heart disease and estimation of risk and prognosis involves recording the 12-lead Electrocardiogram before, during and after exercise, usually on a treadmill.[7]

A clinical survey of 50 cases of patients with coronary risk factors was carried out at Civil Hospital, Ahmedabad over a period of 6 months. These patients were subjected to treadmill stress testing after proper preparation. A permission of Institutional Ethical Committee for

conducting the present study was not required as per the policies of the institute.

***Selection criteria***

1. Patients with increased risk of developing ischemic heart disease in future were selected for the study. The risk factors of interest were hypertension, Diabetes Mellitus, smoking, hyperlipidemia, obesity, and sedentary lifestyle.

2. Patients who had already undergone the TMT stress test were excluded from the study. Patients with history of MI, Percutaneous transluminal coronary angioplasty, Coronary artery bypass graft, arrhythmia, valvular heart diseases, co-morbid condition, chronic conditions like cirrhosis, Cerebro Vascular stroke, Osteoarthritis, chronic renal disease were excluded from the study.

***Patient preparation***

1. The patients were educated about the test and the importance of test for them. The patients were also made aware of the risks involved with the test. Written consent of the patients for performing the test and their participation in study were obtained.
2. A brief history and physical examination was performed and contraindications for the stress testing ruled out.
3. After taking written and informed consent, patients were explained the test procedure in detail.
4. Patient should not take the food, alcohol and caffeine in last 3 hours.
5. Avoid smoking in last 4 hours.
6. Avoid exertion before test.

***Proforma***

*Preliminary data*

Name, age, occupation, socio-economic class, unit, D. O. A, sex, address, reg. no., ward, D. O. D

*Presenting complaints*

Chest pain, dyspnoea, uneasiness, palpitation, perspiration, atypical presentation, precipitating factors.

*Past history and family history*

Ischemic heart disease, hypertension, DM, cerebrovascular accident, drug history.

*Personal history*

Diet, bowel, bladder, sleep, habits - taking tea or coffee/tobacco chewing or smoking/consumption of alcohol.

*Menstrual and obstetric history*

*Risk factors*

Age, sex, occupation, personality, lifestyle: sedentary, habits, hypertension, DM, hyperlipidemia, obesity, positive family history, others.

*General examination*

Height, weight, BMI: [weight (in kg)]/[height (in metre)]$^2$, vital data- temperature, pulse, BP, respiration, jugular venous pulse, cyanosis, edema of feet.

*Systemic examination*

1. Cardiovascular system:
   Inspection, palpation, percussion, auscultation.
2. Respiratory system:
   Inspection, palpation, percussion, auscultation.
3. Alimentary system:
   Inspection, palpation, percussion, auscultation
4. Central Nervous system

***Investigations***

A. Complete blood count

B. Renal function test

C. Liver function test

D. RBS/FBS/PPBS

E. Lipid profile

F. Cardiac markers

G. Chest X-ray

H. Echocardiography

I. Electrocardiogram

J. TMT Test

1. ST segment changes during maximum exercise
2. ST segment changes at 6 min recovery
3. Arrhythmia during TMT test
4. Arrhythmia at 6 min recovery period
5. Pulse rate and BP record during exercise test

## RESULTS

Total 50 cases were studied in study. The following observation was made.

**Table 1: Age incidence with positive TMT Test.**

| Age group (years) | No. of patients | Percentage (%) | No. of patient with +ve TMT test | Percentage (%) |
|---|---|---|---|---|
| **21-30** | 2 | 4 | 0 | 0 |
| **31-40** | 8 | 16 | 3 | 37.5 |
| **41-50** | 20 | 40 | 15 | 75 |
| **51-60** | 15 | 30 | 10 | 66.66 |
| **>60** | 5 | 10 | 2 | 40 |

In the present study, the age group 41-50 years has 75% of positive TMT test and the age group 51-60 years has 66.66% of positive TMT test. So older age have higher chances of Coronary Artery Disease and is a risk factor for Coronary Artery Disease.

**Table 2: Sex Incidence with Positive TMT Test.**

| Sex | No. of patients | Percentage (%) | No. patients with +ve TMT test | Percentage (%) |
|---|---|---|---|---|
| **Male** | 35 | 70 | 25 | 71.42 |
| **Female** | 15 | 30 | 5 | 33.33 |

In the present study, male patients have 71.42% of positive TMT test while female patients have 33.33% of positive TMT test, because up to menopause estrogen is protective against Coronary Artery Disease by maintaining a positive estrogen increase HDL/LDL ratio.

**Table 3: Symptomatology and Incidence**

| Symptoms | No. of patients | Percentage (%) |
|---|---|---|
| **Effort angina (Typical chest pain)** | 22 | 44 |
| **Atypical chest pain** | 8 | 16 |
| **Dyspnea on exertion** | 5 | 10 |
| **Others (palpitation, uneasiness)** | 5 | 10 |
| **Asymptomatic** | 10 | 20 |
| **Total** | 50 | 100 |

In the present study, 44% of patients have typical anginal chest pain, 16% of patients have atypical chest pain, 20% of patients are asymptomatic and 10% of patients have symptoms like palpitation and uneasiness.

**Table 4: Risk factors and incidence.**

| Risk Factors | | No. Of patients | Percentage (%) |
|---|---|---|---|
| **Non modifiable** | Age group (41-50 Year) | 20 | 40 |
| | Sex(Male gender) | 35 | 70 |
| | Personality (Type A) | 10 | 20 |
| | Family H/o Coronary Artery Disease | 8 | 16 |
| **Modifiable** | Hypertension | 27 | 54 |
| | Diabetes mellitus | 22 | 44 |
| | Smoking | 25 | 50 |
| | Hyperlipidemia | 22 | 44 |
| | Obesity | 8 | 16 |
| | Sedentary work | 32 | 64 |
| | Oral contraceptive pills | 1 | 2 |

In the present study, 40% of patients were from the age group 41-50 years, 71.42% of patients have +ve TMT test with male sex, 60% patients have +ve TMT test with type A personality and 63% patients have +ve TMT test with family history of Coronary Artery Disease. All these risk factors are non modifiable.

Modifiable risk factors likes hypertension have 81% of +ve test, diabetics and patients with hypertension have 91% of +ve test, smokers have 80% of +ve test, obese have 63% of +ve test , patients with physical inactivity have 78.12% of +ve test and 50 % patients have +ve TMT test with use of OCPS.

## DISCUSSION

Goldhammer and Scherf had proposed that exercise stress test is useful to confirm the diagnosis of angina.[6] Exercise stress test is the most widely used test for both the diagnosis and prognosis of Ischaemic Heart Disease, which is usually done on a treadmill.[7]

In the present study, patients from the age group of 41-50 (mean age 45 ± 5) years had the maximum (75%) incidences of positive treadmill stress test results. It was also observed that patients with ≤2 coronary risk factors had only 8% incidences of positive treadmill stress test results, whereas patients with ≥3 coronary risk factors had 52% incidences of positive treadmill stress test results.

The age of the patient and the role of multiple coronary risk factors are often underestimated in patients with coronary artery disease. It was found in the present study

that the combination of risk factors is not just a summation of individual risk factors but it is poses a much serious threat than that. The incidence of positive treadmill stress test results increase significantly with the increase in the number of coronary risk factors.

When the patients are in the age ground of 41-50 years or when they have more than 2 coronary risk factors, a treadmill stress test can be a critical test for diagnosis and better prognosis of coronary artery disease. Therefore, it is very important to educate the patients about the significance of the treadmill stress test, the risks associated with it and the facilities available to deal with those risks. Thus, the treadmill stress test is the only non-invasive, reliable and cost-effective tool for diagnosis and better prognosis of coronary artery disease. It also helps in educating patients to alter their lifestyle and to correct the modifiable coronary risk factors.

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