Original Article

Screening for Silent Myocardial Ischemia by Application of Exercise Stress Test: An Observational Cross-Sectional Study

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Abstract

Introduction: Silent myocardial ischemia can be detected using cardiac stress testing. Present study has been carried out by treadmill testing to determine the incidence of the ischemic heart disease (IHD) in asymptomatic individuals with risk factors for coronary artery disease (CAD) and to find out any correlation between multiple CAD risk factors and incidence of IHD in asymptomatic individuals.

Materials and Methods: Eighty-nine asymptomatic patients (age ranges between 20 and 70 years) with important risk factors for CAD were subjected to exercise stress testing (EST).

Results: In total, 21 (23.6%) patients had shown positive treadmill stress test from the study group (89 patients). Maximum number of patients having diabetes mellitus as a sole risk factor (28%) showed positive treadmill test results. Treadmill test was positive in more number of patients having multiple risk factors as comparable to that of only one risk factor.

Conclusion: EST is a simple, easily reproducible, noninvasive, low-cost procedure with relatively good predictive value that can be widely used for CAD detection in the general population. The goals of screening are to improve the quality-of-life and life expectancy through the early detection of CAD.

Keywords: Exercise stress testing, Diabetes, Hypertension, Silent myocardial ischemia, Smoking

INTRODUCTION

Mostly, patients of myocardial infarction (MI) present with significant symptoms and come to the hospital for treatment. However, some individuals have an asymptomatic MI that is identified by the presence of Q-waves in electrocardiogram (ECG). The proportion of silent MIs ranges from 22% to 40%.[1]

Noncommunicable diseases are responsible for most of the mortalities in today's world, and just over half of these are as a result of ischemic heart disease (IHD). The costs of treating this disease and the indirect costs resulting from lost work and wages are substantial.[2]

Almost similar scenario is seen in Indian population which is more prone for IHDs and most of the times; the first episode is the fatal one. Various risk factors are held responsible for the development of IHD that includes hypertension, diabetes, smoking, dyslipidemia, obesity, etc.

Myocardial ischemia is defined as a transient and reversible decrease in oxygen to myocardium, responsible for the following events: Initially, hemodynamic changes followed by kinetic changes (elevated end-diastolic left ventricular pressure), metabolic (lactate production), electrical (repolarization change), and clinical (chest pain) events. Silent myocardial ischemia (SMI) is characterized by lack of final clinical event.[3]

Due to its predictive power, exercise stress testing (EST) has received much attention in recent years. Among asymptomatic individuals, those with an abnormal ECG response during exercise have a substantially higher risk of developing manifest coronary heart disease than those with a normal ECG response.[4]

Functionally, EST determines whether the coronary circulation can increase oxygen supply to the myocardium in response to increased demands that are increased during exercise by increases in systolic pressure, contractile state, and heart rate.[5] It also assesses exercise capacity. In the absence of anemia or disease in the lungs, peripheral circulation or nervous system, the major determinant of exercise capacity is thought to be the heart's ability to increase its output.

SMI can be detected using cardiac stress testing. SMI has been defined as exercise-induced ST depression of >1 mm in the absence of coronary artery disease (CAD) symptoms.[6] Patients with a resting ECG suggestive of ischemia or infarction should undergo stress testing. Furthermore, asymptomatic patients with diabetes and two or more cardiovascular risk factors should also undergo stress testing.[7]

Present study has been carried out by treadmill testing to determine the incidence of the IHD in asymptomatic individuals with risk factors for CAD and to find out any correlation between multiple CAD risk factors and incidence of IHD in asymptomatic individuals.

MATERIALS AND METHODS

Present study was a cross-sectional observational type of study undertaken at Teerthanker Mahaveer Medical College and Research Center, Moradabad, Uttar Pradesh, India from April 2012 to March 2014. We included asymptomatic patients with risk factors for CAD (age ranges between 20 and 70 years of age), attending out-patient Department of Medicine in Teerthanker Mahaveer Medical College and Research Centre, Moradabad. Study has been approved by the Institutional Ethical Committee. Informed consent was taken from each subject participating in the study.

Thus, the study population includes randomly selected asymptomatic patients with important risk factors for IHD like chronic cigarette smoking, obesity, dyslipidemia, Type 2 diabetes mellitus (DM), hypertension, family history of myocardial ischemia at <60 years of age without ECG evidence of IHD. Patients with the history of angina pectoris, MI, Type 1 DM, morbid medical conditions like chronic obstructive pulmonary disease, osteoarthritis, thyrotoxicosis, severe hepatic, renal or metabolic disorders and those patients unwilling to complete exercise test were excluded from the study.

Each patient selected for this treadmill stress testing was evaluated with a detailed history and physical examination pertaining to CAD risk factors. Instructions were given to patients regarding overnight fasting, discontinuation of smoking 1 day before the EST. In addition, instructions about modifying the doses of any medications were given. Patients were told to wear comfortable loose clothing and comfortable shoes. Laboratory investigations like complete hemogram, urine analysis, liver and kidney function tests, blood sugar levels, lipid profile, 12 lead ECG were done on fasting blood sample of each patient.

Procedure

Treadmill testing was performed on asymptomatic patients with risk factors for CAD. Just prior to testing, pulse and blood pressure were recorded in the supine and standing position, and 12c lead ECG was taken. The entire procedure was explained to the patient in detail. Patients were instructed to report immediately when they experience unusual or significant symptoms (e.g., chest pain, dizziness etc.) during exercise. Furthermore, patients were also assured that they may request termination of exercise prematurely, whenever necessary.[8]

Twelve ECG leads were recorded every minute, and blood pressure was measured at rest and the end of each step during exercise. Ventilatory oxygen consumption was estimated by exercise duration expressed in multiples of resting requirements (metabolic equivalents [METs]). The test was stopped when one of the following end-points was reached: Target heart rate, 85% of the predicted heart rate (220 beats/min age in years); severe fatigue; systolic blood pressure reduction; hypertensive response (systolic blood pressure increase 0.250 mmHg and/or diastolic blood pressure 0.115 mmHg).

Results in the form of total exercise time, percentage of maximum heart rate achieved, exercise tolerance, work done in METs, the hemodynamic response, arrhythmias, and chronotropic response were noted.

Interpretation was done as per guidelines of Darrow (1999).[9]

RESULTS

Eighty-nine asymptomatic patients (age ranges between 20 and 70 years) with important risk factors for CAD were subjected to EST in Teerthanker Mahaveer Medical College and Research Center, Moradabad, Uttar Pradesh.

64.04% patients were in the age group of 50 years and above, and 35.96% were below 50 years (Table 1 and Figure 1).

The treadmill test was done in all patients showing any of the above-mentioned risk factors.

Table 1: Distribution of cases according to risk factors

Risk factor	Total cases
DM	41
Hypertension	39
Smoking	16
Dyslipidemia	14
Family history of IHD	7
Obesity	15

IHD: Ischemic heart disease, DM: Diabetes mellitus

Table 2: Results of the treadmill test (age-wise distribution)

Age (years)	Positive EST	Negative EST	Total
20-29	-	4	4
30-39	2	5	7
40-49	5	16	21
50-59	6	21	27
60-69	8	22	30
≥70	-	-	-
Total	21	68	89

EST: Exercise stress testing

Table 3: Results of treadmill test (risk factor-wise distribution)

Risk factor	Positive EST (%)	Negative EST	Total
Diabetes mellitus			
Isolated	7 (28)	18	25
>1 risk factor	8 (50)	8	16
Hypertension			
Isolated	5 (18.5)	22	27
>1 risk factor	5 (41.7)	7	12
Smoking			
Isolated	1 (14.3)	6	7
>1 risk factor	2 (22.2)	7	9
Dyslipidemia			
Isolated	1 (20)	4	5
>1 risk factor	2 (22.2)	7	9
Family history of IHD			
Isolated	0	3	3
>1 risk factor	1 (25)	3	4
Obesity			
Isolated	1 (14.3)	7	8
>1 risk factor	1 (12.5)	6	7

EST: Exercise stress testing, IHD: Ischemic heart disease

In total, 21 (23.6%) patients had shown positive treadmill stress test from the study group (89 patients). Of 21 positive treadmill tests, 14 patients (66.7%) were above the age group 50 years (Table 2, Figure 2).

Table 3 shows that the maximum number of patients having DM as a sole risk factor (28%) showed positive treadmill test results. Also from Table 3, it seems very clear that treadmill test was positive in more number of patients having multiple risk factors as comparable to that of only one risk factor. It shows that there are more chances of having underlying IHD in asymptomatic patients with multiple risk factors for coronary heart disease as comparable to that of single risk factor for the same.

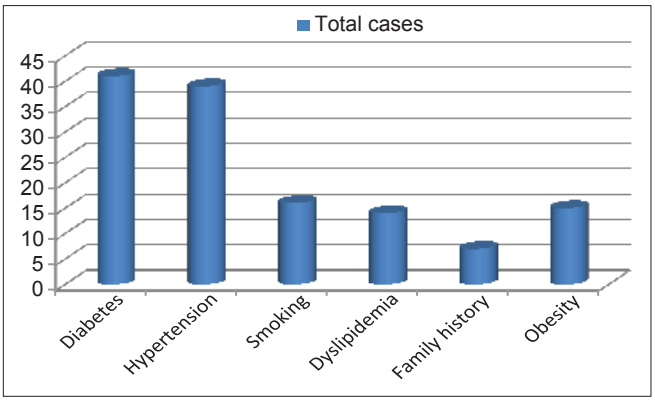

Figure 1: Distribution of cases according to risk factors

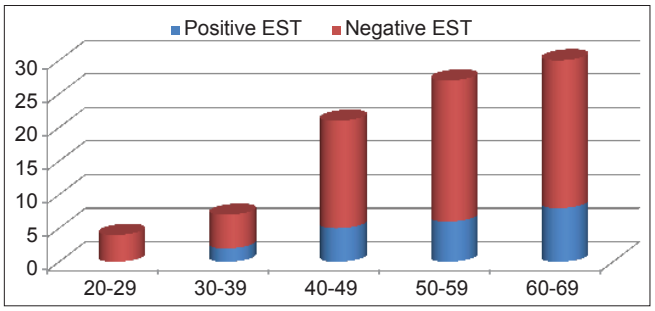

Figure 2: Results of the treadmill test (age-wise distribution)

DISCUSSION

In today's world, the EST is an important simple, easily reproducible, noninvasive investigation for assessing myocardial ischemia that may help to diagnose and for treatment of patients of CAD.

Silent CAD is an important cause of premature death of patients. In approximately 18% of patients with CAD, sudden death is the first and only manifestation.[3]

Main risk factors for IHD are DM, smoking, hypertension, obesity, family history, and dyslipidemia. In patients with DM, CAD is the main cause of mortality and accounts for more than 75% of deaths. SMI is even more frequent, leading to delayed diagnosis and at the time of the diagnosis, disease presents with a more advanced stage.[3] Endothelial dysfunction secondary to DM leads to an inappropriate coronary flow response to increasing metabolic needs of myocardium. Increased threshold of pain perception in diabetic patients, (probably due to enhanced beta-endorphins) and impaired autonomic nervous system may also contribute. The prevalence of

SMI in the diabetic population is variable ranging from 13% to 56%.[10,11]

Smoking (a major IHD risk factor) can induce atherogenesis by carbon monoxide production, stimulates adrenergic system by nicotine thus raising both blood pressure and myocardial oxygen demand. Smoking also induces fall in protective high-density lipoprotein.[12] All the above-mentioned risk factors can induce atherogenesis directly or indirectly.

Agarwal *et al.* (1981) studied 50 subjects and observed positive stress test in 22% cases investigated with important coronary risk factors of age group 40-62 years.[13] Wackers *et al.* (2004) investigated 1123 asymptomatic subjects with DM (age ranges between 50 and 75 years). The subjects undergone either stress testing and clinical follow-up or follow-up only. They observed that total 113 patients were having silent ischemia including 83 with regional myocardial perfusion abnormalities.[14] According to Wahab (2005), prevalence of IHD increases with advancing age. Diabetes poses a substantial threat for development of IHD. If hypertension is also associated, it will substantially increase the risk of both micro-vascular and macro-vascular complications. Decrease in mean systolic blood pressure (10 mmHg) was associated with 12% reduction in risk for any complication related to diabetes, 15% to death and 11% for MI.[15]

In the present study, 89 asymptomatic patients with important risk factors for CAD were subjected to EST. 23.6% patients showed positive EST, which is nearly similar to that of Agarwal *et al.* (22%),[13],Wackers *et al.* (22%).[14]

EST is beneficial in patients at high risk of CAD to determine prognosis and for identifying individuals who may benefit from revascularization. Early screening and intervention in patients with silent ischemia may improve long-term survival.[16]

Patients with a good exercise time on EST should be instructed to report persistent symptoms and for modifications in lifestyle to decrease effects of risk factors. Longer exercise capacity on the treadmill was protective of cardiac events and mortality.[17] In a recent study of 9191 patients, proved that reduced exercise capacity on EST was associated with increased risk for cardiovascular events.[18]

In the present study, there was increasing trend of positive EST with age which was in accordance to study of Wahab[15] In the present study, maximum patients of DM (28%) had positive EST. We can conclude that DM is the most important risk factor for IHD. We have not compared our results with gold standard method that is coronary angiography. Further studies are recommended for evaluating the EST along with comparison with more definitive procedures.

Therefore, early CAD diagnosis can be achieved by screening of SMI, progress in detection, and treatment of CAD can be helpful, which will lead to more effective management and a decrease in cardiovascular complications and mortalities.

CONCLUSION

EST is a simple, easily reproducible, noninvasive, low-cost procedure with relatively good predictive value that can be widely used for CAD detection in the general population. The goals of screening are to improve the quality-of-life and life expectancy through the early detection of CAD.

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