Original Article

A Four-year Observational Study of Exercise Tolerance Test for Evaluation of Patients with Chest Pain in A Tertiary Care Hospital of Bangladesh

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Abstract:

Background: *Cardiovascular disease is a major cause of death worldwide. Ischemic Heart Disease (IHD) is preventable and reversible if early screening and elimination of the risk factors like life style modification and dietary intervention can be done. Stress electrocardiography or treadmill stress testing is a well validated noninvasive diagnostic modality available to clinicians at low cost yet providing valuable functional data for coronary artery disease (CAD) diagnostic and prognostic evaluation.*

Aim of the study: *to know the incidence of positive test suggesting myocardial ischemia among the patient evaluated for chest pain. The demographic and clinical factors associated with those subjects and assessment of exercise capacity of the study group for planning future management.*

Methods: *This is a retrospective observational study was carried out in the department of Cardiology BIRDEM General Hospital Dhaka, Bangladesh from 2021 to 2024. Total 1312 patients who were attend to the institute between 2021 to 2024 was studied and evaluated the patient suspected to have CAD with their functional capacities by doing ETT from inpatient and also from outdoors. Documents were evaluated for Gender, Age, Glycemic Status, Blood Pressure, Dyslipidemia, Body Mass Index (BMI) and the impression of ETT (Positive, Normal, Equivocal, Submaximal and Inconclusive).*

Results: *Among total 1312 patients, 60.1% were male and 39.9% were female. Majority of them were Diabetic and Hypertensive. ETT was found positive among 953 (72.63%) patients with slightly male predominance. Most of the patient having Positive ETT belongs to age 45-57 years. Different types of risk factors were assessed and found in higher incidence among ETT positive study population like 86.51% were over 50 years age group, 79.50% were male, 90.11% of the Diabetes, 86.33% of the Hypertensive. 84.08% had Dyslipidemia and 57.57% of population of had increased BMI. The incidence of positive stress test was proportionately higher in subjects who had greater numbers of comorbidities than those with lesser comorbidities in this study. Functional capacity was assessed by calculating METS during doing ETT revealed 65.5% had above average, 29.5% had average and remainder had below average exercise capacity.*

Conclusion: *Electrocardiographic stress test is a valuable inexpensive non-invasive screening test in patients with multiple risk factors of CAD presented with chest discomfort. It can also be used to assess the functional capacity which will guide further therapeutic measure.*

Key words: *Coronary Artery Disease (CAD), Exercise tolerance test, Ischemic Heart Disease, Metabolic Equivalent.*

Introduction

Treadmill stress testing is a form of cardiovascular stress testing that uses exercise with electrocardiography (ECG) and blood pressure monitoring. ETT has become an important diagnostic tool to evaluate patient with suspected or known cases of heart disease.[1] With treadmill stress testing, providers can determine a patient's functional capacity, assess the probability and extent of coronary artery disease (CAD), and assess the risks, prognosis, and effects of therapy. Stress testing has been used since late 1920s as a convenient, noninvasive way to asses for exercise induced myocardial ischemia[2]. This test is well established, inexpensive, and easily available. Exercise stress testing is an important diagnostic tool for evaluating patient's cardiovascular performance in different settings: after an acute coronary event, after percutaneous coronary intervention or coronary artery bypass graft; in patients risk assessment before non-cardiac surgery; in diabetic population; in patients with baseline electrocardiographic abnormalities. A completely normal ETT has been reported to be a good prognostic

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indicator in diabetic patients[3]. The leading cause of mortality in patients with diabetes is cardiovascular disease (CVD), when it does occur, CVD in diabetic patients is more severe, more complex, and results in higher complication rate than in patients without diabetes[4]. The ETT is preferable to a pharmacological stress test because it represents better cardiac strain with daily cardiac activity and thus depicts the heart's actual workload. Also, patients have the advantage not to get exposed to ionizing radiation and contrast. The more recently developed noninvasive, multislice CT angiography is still recommended to rule out coronary artery disease, but has the associated risk of high radiation exposure and is not cost effective[5]. So, to know the perspective of this test in our country, in a smaller group of population we need to go through the records/data reflecting the statistics of the test reports. From these records the incidence of positive test suggesting myocardial ischemia along with demographic and clinical factors associated with abnormal ETT findings among chest pain patients can be found out. The assessment of functional capacity will guide us future management plan regarding medical/interventional and will also help to determine the over-all prognosis. The main objective is to know the incidence of positive test suggesting myocardial ischemia along with demographic and clinical factors associated with abnormal ETT findings among chest pain patients. Assessment of functional capacity will guide future management plan regarding medical/interventional and will also help to determine the over-all prognosis.

Methods

This is a retrospective observational study was carried out in the department of Cardiology BIRDEM General Hospital Dhaka, Bangladesh from 2021 to 2024. Total 1312 patients who were attended for ETT in the institute (both outdoor and admitted) between 2021 to 2024 was studied and evaluated to find the cause of chest pain and their exercise capacity. Documents were evaluated for Age, Gender, Blood Pressure, BMI and Lipid Profile. Diabetes Mellitus was diagnosed according to the American Diabetes Association (ADA) criteria. Hypertensive heart disease was diagnosed according to Joint National Committee- 7 (JNC-7) guideline. Data were collected from the registered diabetic book's past medical records of the patients and also from computer back up stored data in the ETT machine. These data are regularly checked by the consultant and registrar and corrected accordingly.

Body Mass Index (BMI): Proportion of ideal load for stature determined by partitioning weight of the person in kg by square of tallness in meters. The grouping has been taken from proper weight record according to WHO classification[6].

METs (Metabolic Equivalents) in an exercise stress test (ETT), specifically the Bruce Protocol, are calculated using formulas that relate exercise duration to the energy expenditure of the activity. These calculations are used to assess an individual's exercise capacity and functional capacity. However, commonly it is adapted from statistically derived published tables that convert self-reported functional capacity into METs. In the perioperative literature, functional capacity is classified as excellent (>10 METs), good (7-10 METs), moderate (4-6 METs), poor (<4 METs), or unknown. The ACC/AHA 2014 guidelines use METs extensively in the various recommendations. The ESC/ESA 2014 guidelines base the assessment of functional status solely on METs.[7]

The standard Bruce protocol was used to evaluation of ischemia and angina. The result was considered positive if horizontal or descending ST-segment depression was >=1mm or ST-segment elevation or inotropic failure appeared i.e. fall of systolic arterial blood pressure>10mmHg. Similarly, test was considered negative if the sub- maximum heart rate (85% of the maximum expected rate for age) was achieved without angina or definite ischemic changes. The test result was considered equivocal when there was only minimum T-inversion without ST changes and no definite angina and the result considered inconclusive when target heart rate could not be achieved before that the test has to stopped because of fatigue, tiredness, leg pain, breathing difficulties or patient wants to stop the test.

Statistical Analysis

Data was analyzed for mean, percentage, standard deviation, chi square test, multiple correlation and multivariate analysis, by using SPSS-20 for Windows. The t-test and chi square test will be applied to study quantitative and qualitative data, respectively with P-value <0.05 will be considered significant.

Ethical consideration

Prior to the commencement of the study, the protocol was approved by the ethical committee of Diabetic Association of Bangladesh (BADAS), Dhaka. Aims and objectives of the study along with its procedure, risks and benefits of the study were explained. It was assured that all information and records would be kept confidential and the procedure was helpful for the researcher.

Results

Table I showed the demographic distribution of the study subjects. Male constitute almost 60.1% of the study population and the rest were female. Among them 29.8% male and 26.4% female were above the age of 50 years respectively.

Table I: Demographic Distribution of the Study Subjects (N=1312)

Gender	>50 Years frequency (%)	<50 Years frequency (%)
Male 789 (60.1)	391 (29.8%)	398 (30.3%)
Female 523 (39.9)	347 (26.4%)	176 (13.5%)
Total	738 (56.3%)	574 (43.8%)

Table II shows some comorbidities assessed during doing day to day ETT which includes Diabetes, Hypertension, dyslipidemia and BMI which are found during the assessment of Diabetic book or from the prescriptions. Among them 67.75% subjects were found DM, 51.90% had HTN, 47.40% had dyslipidemia and almost all were on going treatments. On assessment of BMI 33.9% of the study subjects had normal

BMI and remaining around 65.4% had some form increased BMI predominantly overweight group around 50.1%.

Table II: Comorbidities of study population

Comorbidities	Number (%)
DM	889 (67.75 %)
HTN	681 (51.90 %)
Dyslipidemia	622 (47.40 %)
BMI:	
- Normal	445 (33.9%)
- Overweight	657 (50.1%)
- Obese (G-I)	184 (14.0%)
- Obese (G-II)	17 (1.3%)
- Under wt.	9 (0.7%)

Table III showed that, among 1312 of the study population 953 (72.63%) had ETT positive for provocable myocardial ischemia and remaining 21.18% subjects had normal/negative, 2.36% had equivocal, 1.67% had inconclusive and 2.13% couldn't achieve the target heart rate for provoking maximum stress.

Table III: Impression/Results of ETT for Ischemia

Impression	Number (%)
Positive	953 (72.63%)
Normal	278 (21.18%)
Equivocal Stress Test	31 (2.36%)
Submaximal Stress Test	28 (2.13%)
Inconclusive	22 (1.67%)

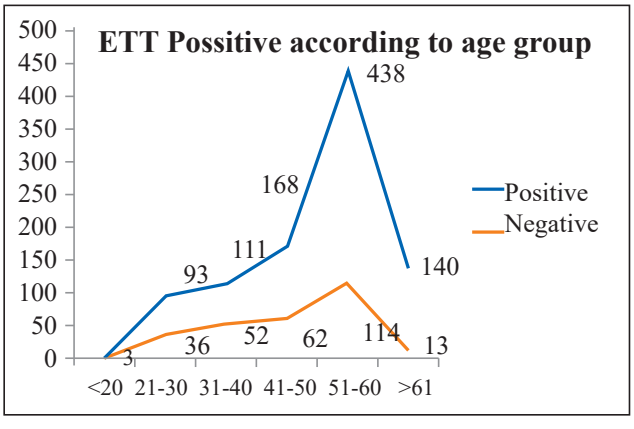

Figure 1: Age distribution of Positive Subjects (n=953)

Figure 1 showed that at the age incidence of subjects with positive stress test tend to rises from age 45 years up to 57 years then declines. Table IV showed that positive ETT cases of this study population are more prone to a age group of 41-60 years with a male predominant.

Table IV: Gender and Age wise distribution of the ETT Positive Subjects (n=1034)

Gender	Age (Years)			
	<20	21-40	41-60	>61
Male	3 (0.2%)	163 (12.4%)	511 (38.9%)	112 (8.5%)
Female	1 (0.1%)	144 (11.0%)	337 (25.7%)	41 (3.1%)
Positive Test	3 (0.2%)	219 (16.7%)	672 (51.2%)	140 (10.7%)
P Value	.001*	.012*	<.001*	

Table V showed that Metabolic Equivalent/ Functional Capacity (METS) of the study subjects were excellent with a low risk of major cardiac event among 65.5% subjects achieving a score of ≥10 METS. Among the other subjects, 29.5% has good (7.0-10.0 METS) functional capacity during doing the stress test. Moderate (4.0-6.9 METS) in 4.6% subjects and Poor (<4 METS) were found among 0.3%. Around 0.4% of the study population the functional capacity could not be assessed. Table VI shows the incidence of positive test among different status of the study population. The positive tests are found more in subjects over 50 years age group and predominantly in male. Among the Diabetic 90.11% and among the Hypertensive 86.33% found to have positive stress test for myocardial ischemia. In comparison to different BMI status of the study subjects ETT found more positive to increase BMI group than normal and its proportionately observed higher in Grade-II (76.47%) than Grade-I (66.84%) than overweight (54.49%) group though the number is higher in overweight group. Dyslipidemia is an important risk factor for developing CAD and in this study, the ETT positive subjects are found more in dyslipidemia group (84.08%). Functional capacity was assessed and among the different categories it has found that majority (59.37%) of the study individual has Excellent functional capacity (METs>10), 29.49% has good exercise capacities and remaining 4.95% individuals has below average functional capacities. The subjects who are advice for ETT were primarily scrutinize for fitness for performing ETT, where gross functional capacities assessed by asking there walking ability or climbing stairs.

Table V: Metabolic Equivalent/ Functional Capacity (METs) (N=1312)

METs	No. (%)
Poor (<4)	4 (0.3)
Moderate (4.0-6.9)	61 (4.6)
Good (7.0-10.0)	387 (29.5)
Excellent (>10)	860 (65.5)
Could not be assessed	5 (0.4%)

Table VI: Distribution of Results of ETT for Ischemia on the basis of risk factor (n=1231, 81 subjects of Submaximal, Equivocal and inconclusive test results are excluded here**)**

Risk Factor	Total	Positive	Negative
Age			
< 50 years	534	350	184
> 50 Years	697	603	94
Sex			
Male	747	594	153
Female	484	359	125
DM Status			
DM	789	711	78
Non-DM	442	242	200
HTN Status			
HTN	600	518	82
Non HTN	631	435	196
Dyslipidemia			
Having Dyslipidemia	622	523	99
Didn't develop yet	609	430	179
Obesity			
Normal	445	103	342
Over weight	657	358	299
Obese Grade-I	184	123	61
Obese Grade-II	17	13	4
METs			
Poor (<4)	4	3 (75.00%)	1
Moderate (4.0-6.9)	61	50 (81.96%)	11
Good (7.0-10.0)	387	291(75.19%)	96
Excellent (>10)	779	609 (78.17%)	170

Table VII shows the pattern of positive test on the basis of number of risk factors assessed in a limited frame in this study and here we can observe that the incidence of subjects having only one risk factor is more but proportionate rate of positive test is more in the subjects who have three or more risk factors.

Table VII: Distribution of test results according to number of associated risk factors

Co morbidity	Total	Positive (%)	Negative
One	540	383 (70.9%)	157
Two	420	343 (81.6%)	77
Three	199	167 (83.9%)	32
More than three	72	60 (83.3%)	12

Discussion:

In our study subjects, male constitute almost 60.1% of the study population and the rest were female. Almost similar demographic distribution has found in a study done by Anisur Rahman Khan et al. done in Bangladesh showed that, out of 200 patients there were 124 (61%) male and 78 (39%) female.[8] In our study the demarcation of age is also reflected that 29.8% male and 26.4% female were above the age of 50 years respectively which is absent in that comparative study.

Among the risk factors assessed in our study, 67.75% were DM, 51.90% had HTN, 47.40% had dyslipidemia and 65.4% had some form increased BMI predominantly overweight group 50.1%. In the study conducted in Bangladesh done by Anisur Rahman Khan et al.8 the same risk factors were estimated and found almost same result.

In our study we found 593 (72.63%) had ETT positive out of 1231. Incidence of positive stress test were higher among individual over 50 years age, in male, in Diabetic (90.11%), in Hypertensive (86.33%), Dyslipidemic (84.08%) and those with increased BMI (obesity-II-76.47%, obesity-I- 66.84% & overweight- 54.49%). In context, a study done by Rahuman MBF et al at Srilanka4 showed among the 3000 subjects 797 (26.6%) were positive and 97.6% were above 41 years of age Dyslipidemia, Diabetes Mellitus, CKD, and smoking were the risk factors present in the population with 57.3%, 62.3%, 34.2%, 1.7% and 4.9% respectively. In another study done by Anisur Rahman et al.1 showed that out of 200 subjects ETT positive cases were 42(21%) and among them 30% was Diabetic, 37% were HTN and 20%were dyslipidemic. Association of smoking, Type-2 Diabetic population specially in male subject was found significant in one study by Nabeel N.F. Hadeed2 at As-Salam Teaching Hospital and Ibn-Seena Teaching Hospital in Mosul, Iraq which we could not include that risk factor in our study as it was not listed in secondary data collected from ETT machine incorporated result shit.

Obesity has been strongly associated with higher cardiovascular morbidity and mortality.[9,10] It has been found previously in large collaborative analyses of individual data from multiple perspective observational studies that each 5 kg/m2 higher BMI was associated with about 40% higher ischemic heart disease mortality. The most likely mechanism of this association is excess body weight contributes directly to cardiovascular risk factors such as diabetes mellitus, hypertension and hypercholesterolaemia.[10] This is also reflected in our study where ETT has been found more positive to increase BMI group than normal and its proportionately observed higher in Grade-II (76.47%) than Grade-I (66.84%) than overweight (54.49%) group.

In this study we also assess the functional capacity of the individuals undertaking ETT by calculating the METs (Metabolic Equivalents). MET is the amount of Oxygen O_2 consumption of an average individual at rest. 1 MET means 3.5 ml O_2/kg/min. Individuals with bellow 5 METs indicates poor prognosis and individuals with a robust exercise capacity (>10 METs) frequently exhibit a favorable outlook, regardless of the extent of anatomical CAD. It's approximated that with

each 1 MET increase in exercise capacity; the survival rate improves by 12%. Notably, failing to achieve 85% of the predicted exercise capacity was significantly linked to an elevated risk of myocardial infarction, unstable angina, the need for coronary revascularization, and mortality.[11-14] In our study we found that majority 59.37% of the study individual functional capacity (METs>10), 29.49% has (METs→7-10) and remaining 4.95% individuals has below average functional capacities. Incidence of positive test are proportionately higher among those with moderate functional capacity (METs→ 4.0-6.9). Similar findings were observed in a study carried in Shri Lanka by Rahuman MBF et al. where out of the 3000 patients, 797 (26.6%) positive, 1896 (63.2%) negative and 307 (10.2%) inconclusive ETT outcomes were found and majority 40.21% (312) of total were noted to be positive, among the patients with (METs <7).[15]

Conclusion

The study concludes that ETT was found positive among patients of 45-57 years age group with slightly male predominance. Majority of them were Diabetic, Hypertensive, Dyslipidemic and had increased BMI. Among the study population it was found that 65.5% had above average, 29.5% had average and the remainder had below average exercise capacity. Therefore, a treadmill stress test (TMT/ETT) can be an initial non-invasive test for diagnosing, for guiding the treatment plan (medical/invasive) and to determine prognosis of coronary artery disease specially in individuals of 45 years and above age group having two or more coronary risk factors in our country.

Disclosure: There is no conflict of interest

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