Exercise ECG Testing – Is It Obsolete?

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Abstract
Role of exercise ECG Testing has become controversial with the emergence of so many non-invasive imaging modalities. In spite of that, Exercise ECG Testing still remains the best modality as an initial test for evaluation of chest pain, prognostication and risk stratification of coronary artery disease, rehabilitation following myocardial infarction and various re-vascularization procedures. Further, the test has also been used in other cardiovascular diseases other than coronary artery disease.

A large number of diagnostic and prognostic tests are available to evaluate coronary artery disease (CAD). Exercise ECG testing still remains the choice of test used for this purpose. In the developing scenario with wide variety of available imaging modalities like stress echocardiography, nuclear imaging, CT/MRI based myocardial viability and non-invasive coronary angiography and the coronary angiography – the gold standard, there has been question on the usefulness of Exercise ECG Testing.

Exercise ECG Testing is still the most important tool, if evaluated properly, can give useful prognostic and diagnostic information in evaluation of not only coronary artery disease but also in various other cardiovascular diseases.

While addressing the issue of usefulness of Exercise ECG Testing, the following questions need to be addressed:

1. Whether the test is useful in evaluation of CAD?
2. Whether the test is also useful in special situations where there is considerable doubt about its usefulness?
   a. Women
   b. Resting ECG abnormalities
   c. Conduction abnormalities like LBBB/RBBB
3. Whether the test is useful in other situations, apart from coronary artery disease?
4. Cost-Effectiveness of the test
5. Safety of the test

Exercise ECG Testing in evaluation of CAD
Exercise ECG Testing still remains the first choice of the test in evaluation of suspected coronary artery disease. The sensitivity and the specificity of test is 68% and 77% respectively. In patients with single vessel disease, the sensitivity ranges from 25 to 71%, exercise induced ST depression most frequent with Left Anterior Descending Artery (LAD), followed by Right Coronary Artery (RCA) and then by Left Circumflex Artery (LCx). Patients with multivessel disease, the sensitivity and specificity of the test are approx. 81% and 66% respectively. Exercise ECG Testing is basically done to look for ischaemia by seeing the horizontal or downsloping ST segment depression of 1 mm or more at 80 msec from J point. However, Exercise ECG Test needs to be evaluated more carefully for all the following parameters to have a good overall assessment of the test:

1. Heart Rate (HR)
2. BP Response
3. HR-BP Product
4. METs (Metabolic Equivalent) achieved
5. Number of leads showing ST depression
6. Recovery phase and recovery time
7. ST segment elevation
8. Development of symptoms
9. Development of arrhythmias

In general, the heart rate increases with increasing workload. However, excessive rise in heart rate at a low workload usually suggest deconditioning status or severe cardiac disease. It is advisable to repeat the test after proper conditioning of the patient and evaluate the test in new settings. Chronotropic incompetence – failure to achieve the desired heart rate is also considered to be an important factor to signify underlying severe cardiac disease or sinus node dysfunction. Further, slowed heart rate recovery (HRR) of less than 12 beats per minute in the first minute after an exercise stress test has been suggested as a useful addition to the criteria used to assess exercise stress test results. Patients showing such response have shown 4-fold greater mortality than those who had a rapid fall in heart rate.
Systolic Blood Pressure (SBP) normally rises progressively with increasing workloads and attains 160 to 220 mm Hg at peak exercise. At peak exercise there may be slight drop in blood pressure up to 10 mm Hg that is in response to peripheral vasodilatation. Failure of SBP to rise to 130 mm Hg or more than 10 mm Hg fall in BP signifies LV dysfunction or severe coronary artery disease.\(^5\) Abnormal rise of SBP (≥ 214 mm Hg) with resting normal SBP is a good predictor of future sustained hypertension, estimated to be approximately 10-26% in coming 5-10 years.\(^7\) Failure of SBP to fall rapidly may also signify the presence of underlying severe CAD and poor prognosis. At 3 minutes post-exercise, SBP more than 90% of peak exercise suggests myocardial ischaemia. SBP Ratio (SBP at 3 minutes recovery divided by the SBP at peak exercise) was significantly higher in patients with Coronary stenoses than those without. SBP ratio of greater than 0.87 was associated with significant stenoses;\(^7\) SBP greater than 195 mm Hg at 2 minutes recovery was associated with 1.7 fold increased risk of acute MI and each 10 mm Hg increase at 2 minutes recovery was associated with 7% increased risk of AMI, even after adjustment of resting BP.\(^9\)

Certain patients show ST changes during recovery phase only. Lanza et al concluded that the data gained during recovery phase is “largely comparable” to that obtained during effort and may add significantly to the clinical information derived from the results of exercise stress test.\(^1\)

Horizontal or down-sloping ST segment depression is the usual response to depict myocardial ischaemia, but is unable to locate the culprit vessel. ST elevation in the leads without Q waves during Exercise ECG Testing is rare occurrence and has been noted from 0.2 to 1.7% and the correlation of ST elevation and the culprit vessel is generally quiet good.\(^12\) ST elevation in anterior leads indicates LAD disease in 93% of cases and in inferior leads indicates a lesion in or proximal to PDA in 86% of cases.\(^13\)

Exercise induced complete RBBB or LBBB is generally non-specific. But when found together with other evidence of myocardial ischaemia, it may localize the lesion in proximal LAD.\(^14\)

Failure to achieve adequate exercise workload (METs) can be due to deconditioning of the patients, non-cardiac disability or severe CAD. Patients of Myocardial infarction undergoing exercise testing achieving less than 5 METs have a worse prognosis as compared to those who have better effort tolerance.

While stratifying the results of exercise testing, it is very important to see the HR response (poor Chronotropic response, accelerated HR response or slower recovery), BP response (fall in SBP or slower recovery), METs achieved (less than 5 METS), number of leads showing ST segment depression (more than 5 leads), delayed recovery (more than 6 minutes), type of ST changes (presence of ST elevation), development of symptoms and malignant arrhythmias.

**Exercise ECG Testing in special situations**

There are some situations where the ability of Exercise ECG Testing is in doubt. Let us analyze such situations and see how useful Exercise ECG Testing in such situations is:

**Women**

As compared to men, the sensitivity & specificity of Exercise ECG Testing in women for evaluation of obstructive CAD is less. In the largest published series of Exercise ECG Testing in women, Alexander et al, reported 19.1, 34.9 and 89.2% of 976 subjects evaluated, showed more than 75% or greater luminal narrowing with low, medium and high risk Duke Treadmill Score (DTS) respectively and 3.5, 12.4 and 46% of the subjects had multivessel CAD in same subjects. Comparing DTS in 976 women to 2249 men, Alexander et al reported 1, 2.2 and 3.6% mortality over 2 years in low, medium and high risk DTS scores in women, compared to 1.7, 5.8 and 16.6% in men.\(^15\)

In an ongoing study at our center, women presenting with chest pain and having negative exercise test almost excludes the presence of obstructive CAD.

With an experience of over 13000 Exercise ECG Testing at our hospital, following points have been observed as far as Exercise ECG Testing in women is concerned:

1. If Exercise ECG Testing is negative at ≥ 7 METs – almost excludes obstructive CAD
2. If basal ECG shows postural or hyperventilation changes and positive Exercise ECG shows similar, but enhanced changes and rapid recovery – indicates false positive test
3. If Exercise ECG Test is positive only in inferior leads (L II, L III and aVF) – likely to be false positive test
4. If Exercise ECG Test is positive at ≤ 5 METs with typical horizontal or downsloping ST segment depression of ≥ 2 mm in more than 5 leads, having delayed recovery and associated with typical chest pain, chances of obstructive CAD is very high.

In our center, we divide women undergoing Exercise ECG Testing in 4 groups:

1. Negative Test
2. Low Risk DTS
3. Moderate Risk DTS
4. High Risk DTS

Women with negative Exercise ECG Test are not subjected for any further tests. Women with low and moderate risk DTS are evaluated more in detail with the history and risk factors and Exercise ECG is interpreted considering all the points mentioned above and then
either kept under observation alone and advised to undergo repeat Exercise ECG Testing after 6-12 months or subjected to one of the non-invasive imaging tests and if any suggestion, then subjected for coronary angiography. However women with high-risk DTS scores are subjected for coronary angiography.

It is concluded that very important prognostic and diagnostic information can be obtained from Exercise ECG Testing in women if history and Exercise ECG Test are carefully evaluated and interpreted.

**Exercise ECG Testing with resting ST segment abnormalities**

2 mm or more additional ST segment depression is useful marker in interpreting the Exercise ECG Test with resting ST segment depression.1

**Exercise ECG Testing with conduction disturbances**

RBBB : Exercise induced ST segment depression is commonly seen in anterior leads (v1 – v3) and has no relevance to the presence of ischaemia. However, ST segment depression in lateral leads (v4 – v6) and inferior leads (II, III, and aVF) has same significance as of normal ECG while interpreting the Exercise ECG Test.1

LBBB : Exercise ECG Test is not useful test to evaluate ischaemia in presence of LBBB as upto 10 mm ST segment depression may be seen in exercise without the presence of CAD. However, Exercise ECG Test can give information like functional capacity, development of symptoms, chronotropic response, BP response, HR-BP product, which may be taken as indirect parameters to assess the presence of obstructive CAD.1

**Usefulness of Exercise ECG Testing in other situations apart from evaluation of ischaemia**

**Rheumatic Heart Disease/Congenital Heart Disease**

Exercise ECG Testing can be performed in certain cases of Rheumatic Heart Diseases and Congenital Heart Diseases to evaluate the functional capacity of the patient where subjective symptoms are not correlating with the clinical examination and it helps in final decision making for further management of the case1.

**Evaluation of arrhythmias**

Exercise ECG Testing may unmask ischaemia if suspected as the cause of resting ventricular premature beats or complex ventricular arrhythmias. Exercise induced ventricular arrhythmias (EIVAs) are associated with 3 fold higher mortality than those without EIVAs. Exercise induced complex ectopy have poorer prognosis than with simple ectopy. Patients developing ventricular tachycardia on exercise who are already on antiarrhythmics have increased chances of sudden cardiac death.6,17,18

**WPW Syndrome**

Exercise ECG Test is again not a good test for evaluation of ischaemia in presence of WPW Syndrome. However, abrupt loss of pre-excitation on exercise is good evidence of longer antegrade effective refractive period of the accessory pathway and these persons are unlikely to develop fast ventricular response during episodes of atrial arrhythmias.3

**Atrial Fibrillation**

Exercise ECG Test can give a better rate control in patients with atrial fibrillation then with resting ECG alone and dose titration can be done effectively.15

**Sinus Node Dysfunction**

Poor chronotropic response especially not achieving heart rate more than 100 beats per minute on maximal exercise can be taken as good evidence for underlying sinus node dysfunction (not on betabockers or calcium channel blockers). However, negative test does not rule out sinus node dysfunction.19

**Pacemakers**

Exercise ECG Test is not useful in patients who are on permanent pacemakers. However, Exercise ECG Test can be performed in Rate-Adaptive Pacemakers to fine-tune these devices.20,21

In patients having ICD, the test shall be performed carefully. Either, the test shall be terminated suboptimally (10 beats below the detection level) or the device may be temporarily deactivated or reprogrammed for faster rate.

**Cost Effectiveness**

The Exercise ECG Test still remains the most cost-effective test for evaluation of obstructive CAD and gives a host of physiological information, which is not available with other imaging tests.

**Safety**

Exercise ECG Test has a very safe record. Overall morbidity and mortality reported is 0.05% and 0.01% respectively. Even if the test is performed in setting of acute myocardial infarction (AMI) within 4 weeks, the morbidity and mortality are 0.09% and 0.03% respectively.12 Our center, performed more than 13000 tests, no mortality has occurred so far and 7 hospitalizations were needed – 1 patient for NSTEMI, 3 patients who developed complex ventricular arrhythmias (did not require any drugs or electrical therapy) and 3 patients developed hypotension again settled down over 8-12 hours without any therapy.

However, no exercise test shall be performed without proper resuscitation cart having endotracheal tubes and all necessary drugs and defibrillator kept ready for any emergency.

**CONCLUSION**

To conclude, Exercise ECG Test not only can give information regarding presence or absence of ischaemia in suspected obstructive CAD either in general population or in special situations, but also can give a wealth of information in other cardiovascular diseases. It is cost effective and very safe. So Exercise ECG Testing
still remains the most useful test because of wide availability, reasonable cost, proven safety and easy interpretation. The use of clinical data can add to the utility of the stress test.

REFERENCES


Announcement

The 24th Annual National Conference of Geriatric Society of India will be conducted at Pondicherry on 3rd and 4th September 2005.

The Registration Fee is as follows:

1. For Delegates Rs. 1000.00
2. For Post Graduate Students Rs. 300.00
3. Spot Registration Rs. 2000.00

The last date for registration is 6th August 2005

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