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Does Cardiac Exercise Stress Testing Still Exist?

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Abstract

Exercise Treadmill Testing to identify CAD is now a widely available and relatively low-cost examination that has been used for more than 60 years. The use of the ETT has expanded to include testing for functional capacity, chronotropic incompetence, assess the effects of therapy and also useful for risk stratification of patients with known CAD. The test sensitivity ranges from 61% to 73%, as reported by various analysts, and Specificity ranges from 59% to 81%, depending on the study or article referenced. Due to the various criteria set for the exercise stress test interpretation and reporting, we have outlined the criteria needed to support high quality exercise stress testing practice throughout Health facilities.

Keywords: ***Coronary artery disease; Acute myocardial infarction; Cardiac arrhythmias***

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Introduction

Coronary artery disease remains responsible for about one-third or more of all deaths in individuals over age 35 [1,2]. Exercise stress testing, which is now widely available at a relatively low cost. The test sensitivity ranges from 61% to 73%, as reported by various analysts, and specificity ranges from 59% to 81%, depending on the study or article referenced. Exercise stress testing is used to assess the probability, extent and prognosis of having coronary disease. It is also useful for risk stratification of patients with known CAD [3,4].

The absolute contraindications of exercise stress testing include acute myocardial infarction within 2 days, Unstable angina not previously stabilized by medical therapy, Uncontrolled cardiac arrhythmias, Uncontrolled symptomatic heart failure, Acute pulmonary embolus or pulmonary infarction, Acute myocarditis or pericarditis, Active endocarditis, Symptomatic severe aortic stenosis, Acute aortic dissection and Physical disability that precludes safe and adequate testing.

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While Relative contraindications include left main coronary stenosis, Moderate valvular stenotic disease, Uncorrected medical conditions, such as significant anemia, important electrolyte imbalance, and hyperthyroidism, Severe arterial hypertension with systolic BP>200 mmHg in addition to or diastolic BP >110 mmHg, tachyarrhythmia or bradyarrhythmia, High-degree (AV) block, hypertrophic obstructive cardiomyopathy or any other forms of outflow tract obstruction, Inability to exercise adequately due to mental or physical impairment and recent stroke or TIA [4].

Very little evidence exists in the safety of early exercise testing in unstable angina. Three studies were found covering 632 patients with stabilized UA who had a 0.5% rate of death or MI within 24 hours of their exercise test [5].

Exercise Stress Testing (Prognostic Score, Measurements & Protocol)

The annual risk of cardiovascular mortality can be quantified from stress test results by measures such as the Duke treadmill score (Prognostic Exercise Test Scores) (Table 1) [5].

Time in minutes on Bruce protocol=		--
5 x amount of ST depression in mm=		--
4 x angina index (0= no angina on test, 1=angina, not limiting, 2= limiting angina)		--
Total Score	**Risk Group**	**Annual Mortality %**
>= 5	**Low**	0.25
4-10	**Intermediate**	1.25
>= 11	**High**	5.25

Table 1: Duke Treadmill Score: Calculation & Interpretation

The useful measurements identified for safety purposes and for estimating the adequacy of the stress to evoke inducible ischemia is Age-predicted maximum heart rate, achieving 80% is considered a good test result. It can be calculated by: {220 (standard deviation, 10-12 beats/min) - Age (in years)}.

The Pretest probability is estimated Based on the Diamond and Forrester score using the three criteria that specified the chest pain to coronary artery disease which include retrosternal, exertional and relieved with rest. The interpretation should be matched to the certain sex & age group (Table 2) [6].

Criteria of chest pain
Substernal Chest Pain
Exertional Chest Pain
Chest Pain Relieved with rest
Interpretation (with age & sex):
Typical Angina: 3 Criteria from above
Age 30-39: 76% likelihood (intermediate) in men & 26% in women (intermediate)
Age 40-49: 87% likelihood (high) in men & 55% in women (intermediate)
Age 50-59: 93% likelihood (high) in men & 73% in women (intermediate)
Age 60-69: 94% likelihood (high) in men & 86% in women (high)
Atypical Angina: 2 Criteria from above

Age 30-39: 34% likelihood (intermediate) in men & 12% in women (low)
Age 40-49: 51% likelihood (intermediate) in men & 22% in women (low)
Age 50-59: 65% likelihood (intermediate) in men & 31% in women (intermediate)
Age 60-69: 72% likelihood (intermediate) in men & 51% in women (intermediate)
Non Angina Chest Pain: 1 Criteria From Above
Age 30-39: 4% likelihood (low) in men & 2% in women (low)
Age 40-49: 13% likelihood (intermediate) in men & 3% in women (low)
Age 50-59: 20% likelihood (intermediate) in men & 7% in women (low)
Age 60-69: 27% likelihood (intermediate) in men & 14% in women (intermediate)
No Criteria Present
Risk is low to very low in both men & women
Application
Ø **Low risk patient: Avoid Stress Testing (higher risk of false positive)**
Ø **Intermediate risk patient: For Stress Testing**
o Exercise Stress Test is first line for both men & women
o Stress Imaging Test if abnormal baseline ECG, prior revascularization or DM
o Pharmacological Stress Test if unable to exercise
Ø **High risk patient: Consider Coronary Angiogram**

Table 2: Pretest Probability Based on the Diamond and Forrester Score.

Indications for Termination

Clinical developments of angina, hypotension in >10 mmHg SBP from baseline with ischemia, arrhythmia or signs of poor perfusion are absolute indication to stop the test [4]. An important reason to stop the test is ST elevation (> 1 mm) in leads without diagnostic Q waves (other than V 1 or a VR) [7].

Relative contraindications include SOB, leg cramps, claudication and development of BBB, hypertensive response; SBP more than 250 mmHg, DBP more than 115 mmHg, or both [4].

Interpretation of Test

Parameters that should be interpreted in exercise testing are functional capacity, vital sign changes & ECG abnormalities.

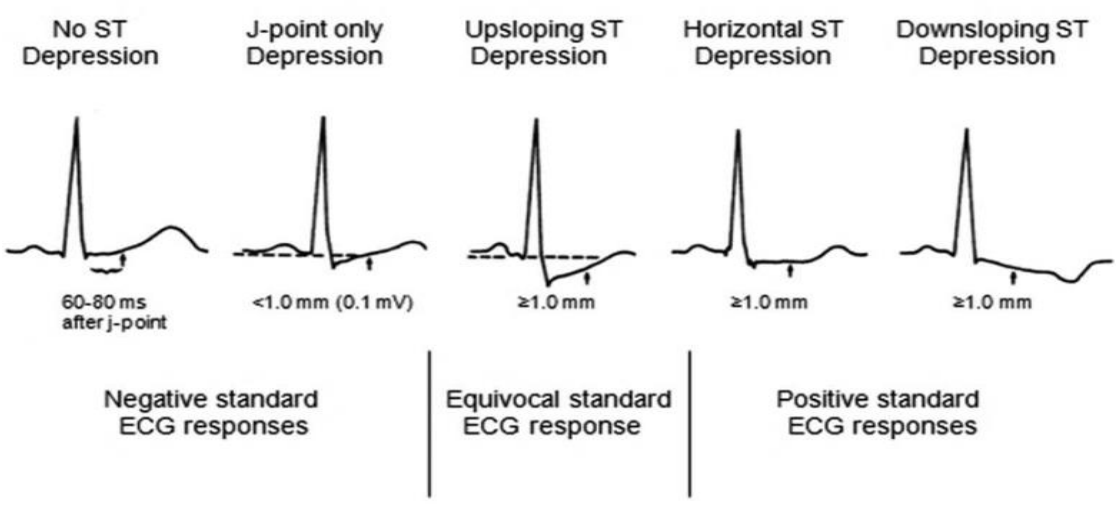

Figure 1: ST Segment Depression during Exercise.

The standard criteria for test positivity include horizontal or down sloping ST depression ≥1 mm (0.1 mV) at 60 to 80 ms after the J point in 3 consecutive beats. However, up sloping ST depression during exercise is not usefully predictive for the presence of myocardial ischemia in general populations. All ST depression <0.1 mm additional from baseline is defined as negative. (Figure 1) [4].

A pattern of characteristic alterations known as the ischemic cascade develops with reduced left ventricular compliance followed by localized wall motion abnormalities, increased left ventricular end-diastolic pressure, ST segment changes, and lastly angina. (Figure 2) [8].

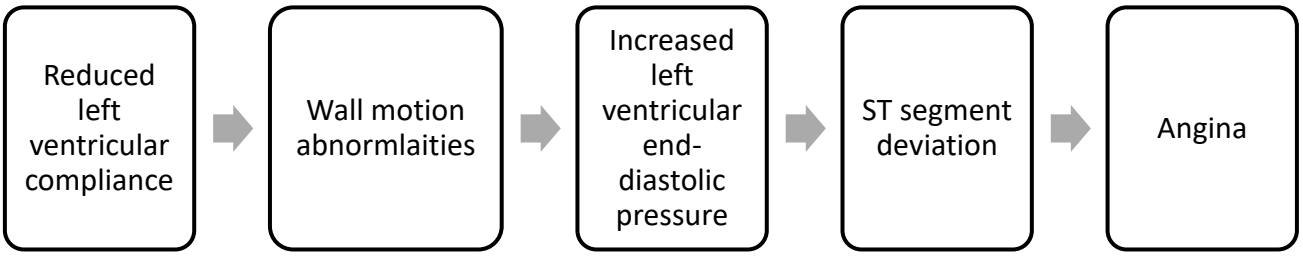

Figure 2: The Ischemic Cascade

Systolic BP rises with increasing dynamic work as a result of increasing cardiac output, whereas DBP usually remains about the same or is moderately decreased because of vasodilatation of the vascular bed. The average rise in SBP during a progressive exercise test is about 10 mm Hg/MET. After maximum exercise, SBP usually declines because of the rapid decrease in COP, normally reaching resting levels or lower within 6 minutes, and even remaining lower than pre-exercise levels for several hours [8].

Hypertension per se is not an indication for exercise testing, but it is very often present in individuals who are referred for testing. The test should be postponed if resting SBP >200 mmHg or if DBP >115 mmHg. An exaggerated SBP response to exercise has been defined as a maximal value of ≥210 mmHg for men and ≥190 mmHg for women. It could indicate an increased risk for future hypertension, LV hypertrophy, and CV events. A rise in DBP during exercise of >10 mmHg above the resting value (or an absolute value of 90 mmHg) also is considered abnormal and could predict increased likelihood of CAD. A failure of SBP to fall or a rise in the short-term recovery period, relative to the maximal exercise value, has been shown to be predictive of an increased risk of death [8].

Chronotropic Incompetence

Chronotropic incompetence defined as inability to achieve ≥85% of age-predicted maximum HR. Inadequate HR response to exercise can be a marker not only for sinus node dysfunction but also for prognostically important cardiac disease and has been defined as chronotropic incompetence [9].

Heart Rate Recovery

Heart rate declined rapidly after termination of the exercise is considered positive prognostic value and is likely due to vagal reactivation. Abnormality of HR recovery is defined when the decline in HR from peak exercise is ≤12 beats per minute after termination of the exercise test [5].

Complications

Exercise Testing can cause wide range of complications, which may include cardiac arrhythmias', hemodynamic un-stabilities, acute cardiac ischemia and heart failure. Death rarely occurs frequency (estimated at 1 per 10,000 tests, perhaps less). Non-cardiac complications include musculoskeletal trauma and soft-tissue injury [8,9].

Pharmacological Stress Testing

Pharmacological Stress Testing should be considered when patients are unable to exercise due to physical limitation or in cases with non-interpreted ECG. Stress nuclear myocardial perfusion imaging can be performed as single-photon emission computed tomography (SPECT) or positron emission tomography (PET).

Echocardiography With exercise stress, images are obtained in several views with ECG gating (i.e. synchronized to the QRS complex) at rest and while the patient performs stationary cycling or immediately after treadmill exercise [10].

Conclusion

Stress testing still considered the most cost-effective method to identify significant myocardial ischemia due to CAD [11]. In selected cases stress imaging using either exercise or pharmacological stress may be more appropriate [12]. Results should always be interpreted in the context of the patient's clinical history.

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