Exercise Tolerance Testing

Synonyms: include exercise ECG testing, treadmill testing, exercise stress test

Chest pain is a common presentation both to general practitioners and to A&E departments. Often one of the main differentials is cardiac chest pain and ruling this out in patients who might be otherwise well or only have one or two cardiac risk factors, can be difficult. Exercise tolerance testing (ETT) is one method which is used to determine the presence of significant coronary heart disease.

ETT has been quoted as having a sensitivity of 78% and a specificity of 70% in detecting coronary artery disease (CAD). Thus, a negative test may not necessarily be true and further testing or advice may be warranted. Diagnostic accuracy is also poor in women and this may relate to smaller heart size. For this reason, ETT is being superseded by cardiac imaging techniques, such as myocardial perfusion scans, in some centres. Even so, ETT can be valuable when performed in selected patients and the following criteria have been suggested:

- Ability to exercise.
- Normal baseline 12-lead ECG.
- No previous cardiac revascularisation.

Indications for exercise tolerance testing

- Diagnosis of coronary heart disease (keeping in mind the high number of false positives and false negatives).
- Assessment of ‘fitness’ in certain occupations and medical condition - eg, the police force and some cardiomyopathies.
- Arrhythmias - ETT can help to record arrhythmias which are provoked by exercise (but only in those with non-life-threatening arrhythmias).

Most patients with suspected angina were traditionally referred for exercise ECG testing. Exercise ECG testing has a relatively high sensitivity but only moderate specificity for the diagnosis of CAD. A normal exercise test may reassure many patients but it does not exclude a diagnosis of CAD. The 2010 National Institute for Health and Care Excellence (NICE) guidance for patients presenting with chest pain recommends that exercise ECG should not be used to diagnose or exclude stable angina for people without known CAD.

The NICE guidance also states that, for people with confirmed CAD (eg, previous myocardial infarction, revascularisation, previous angiography), non-invasive functional testing should be offered when there is uncertainty about whether chest pain is caused by myocardial ischaemia, and that exercise ECG may be used instead of functional imaging.

What the exercise tolerance test involves

- ETT consists of exercising on a treadmill following a defined protocol, the Bruce protocol, over approximately 20 minutes. The test begins gently and gradually the level of intensity is increased through a combination of increased treadmill speed and incline.
- Intensity of exercise is measured in metabolic equivalents (METs) where 1 MET is the amount of energy expended at rest or 3.5 ml oxygen per kilogram per minute.
- The test is divided into seven stages of three minutes and there is also a less strenuous version called the modified Bruce.
- ECG is recorded throughout and blood pressure measured intermittently.
- ETT might be prematurely stopped for any of the following: development of chest pain, presence of ST elevation, very deep, 2 mm or more, ST depression, arrhythmias, hypotension or if the patient becomes tired and is unable to continue. In addition, elevation of blood pressure to dangerous levels such as >250/115 mm Hg should also lead to termination of the test.
- Beta-blockers and digoxin can interfere with the results so are usually stopped before the ETT.

Contra-indications to exercise tolerance testing

- Chest pain at rest or at night.
- Any condition where left ventricular output is reduced - eg, aortic stenosis or hypertrophic obstructive cardiomyopathy (HOCM).
- Active systemic illness.
- Abnormal baseline ECG (eg, bundle branch block patterns or left ventricular hypertrophy); these make interpretation of the ETT difficult.
- Suspected or confirmed life-threatening arrhythmias.

Interpreting the exercise tolerance test

- ST elevation - usually this will be picked up straightaway and dealt with.
- The patient is normally considered to have been adequately ‘stressed’ if they achieve 85% or more of their maximum heart rate (calculated as 220 - age in years for men and 210 - age for women). However, recent data suggest that using these criteria to terminate the test may lead to an underestimation of inducible ischaemia.
At each stage each lead should be examined for:
- Planar ST depression (this can be difficult to delineate from depression of the J point, which is the point where the QRS complex meets the ST wave).
- ‘Flipping’ of the T waves.
- Arrhythmias.
- Examination of all leads should continue into the recovery stage after the exercise stage of the test has been completed.

Complications
These are rare but can be fatal - eg, myocardial infarction, left ventricular rupture, ventricular fibrillation or ventricular tachycardia.

Following up an abnormal exercise tolerance test
- Referral to cardiologists if an adequate ETT was undertaken and is abnormal.
- If an inadequate test was performed, further non-invasive investigations may be indicated, such as myocardial perfusion scanning, cardiac MRI, or stress echocardiogram. These are usually requested by the cardiologists, so a referral or discussion may be needed.

Further reading & references

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