Stress echocardiography

This week's Update looks at the reasons for using stress echocardiography and interpreting the results.

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Introduction

AN exercise stress echocardiogram (stress echo) includes everything done in an exercise stress ECG with echocardiogram images of the left ventricle (LV) acquired pre- and post-exercise. Essentially, all the diagnostic and prognostic information obtained during a stress ECG is also obtained during a stress echo.

The echo images provide diagnostic and prognostic information, which is not only additional to that obtained from the stress ECG but, in fact, makes a much greater contribution to the accuracy of the test than the contribution of the stress ECG and clinical information combined.

The resting echocardiogram: ancillary information

The extent of the cardiac assessment on the resting component of the stress echo varies depending on the operator, from no assessment (other than LV function) to a full echocardiogram (including assessment of valves, pericardial effusion and aorta).

One approach is to perform a full resting echocardiogram and provide a separate report.

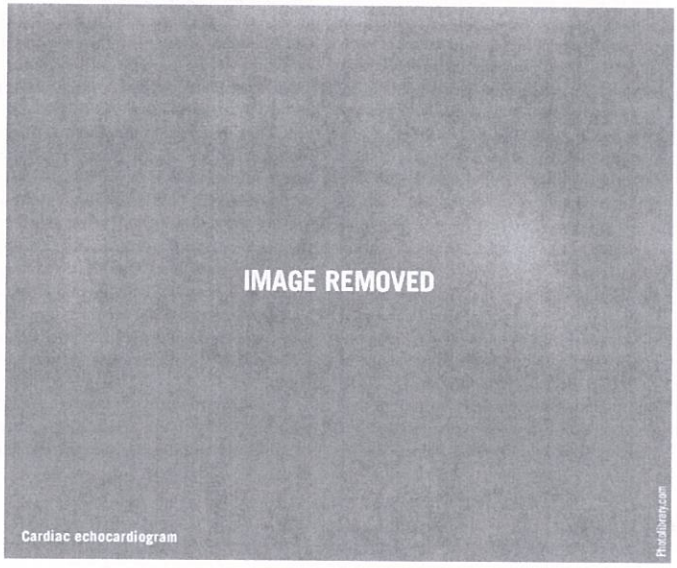
This avoids falsely attributing abnormal LV function to coronary disease when it is, in fact, due to significant valve disease; frequently provides clinically useful information; and prevents the false assumption that a full resting echocardiogram has been performed, an assumption that can lead to serious management errors.

How stress echocardiography works

The studies are analysed using the 16-segment model where the left ventricle is divided into 16 segments and each segment is ascribed to one of the three coronary artery territories (see Figure 1 on page 38). The wall motion of each segment is scored at rest and then immediately post-exercise while the heart is still working hard, that is, 'stressed'. The segments are usually scored visually, although quantitative methods are being researched and are beginning to be used.

Stress echo detects ischaemia through direct visualisation of the loss of contractility (hypokinesis) in the segments of the LV affected by ischaemia induced by stress (exercise or dobutamine). Hypokinesis occurs at a lower threshold of stress than either ECG changes or angina. The 'ischaemic cascade' describes this phenomenon.

When the heart is subjected to stress, wall motion abnormalities occur at the lowest threshold of stress, followed by



ECG changes and then the manifestation of angina. Unlike a stress ECG, a stress echo can localise and quantitate ischaemia. The pre-and post-LV images are reviewed with specialised computer software customised to facilitate interpretation, which can include:

- Playing the images side-by-side on continuous loops
- Rate 'adjustment' of the post-images so that the contraction of the LV in pre- and post-images is synchronised
- Freeze-frame
- Slow motion.

Dobutamine stress echocardiography

Some patients are unable to exercise for various reasons (e.g. orthopaedic problems, previous stroke, other neurological disease or peripheral vascular disease in the lower limbs). For these patients, dobutamine stress echo can be performed with the patient lying down. Dobutamine increases the force and rate of cardiac contraction and, therefore, can stress the heart without exercise. Dobutamine is short-acting and is cleared from the patient's system in about 10 minutes.

One particular use of dobutamine stress echo is to assess for myocardial viability in patients who have resting left ventricular systolic dysfunction. The dobutamine improves the wall motion of viable segments. This is an indication that cardiologists rather than GPs would use.

Viability cannot be assessed on an exercise stress echo. A rule of thumb is that if the resting LV ejection fraction is less than 35%, a dobutamine rather than exercise stress echo is more likely to be the most useful test. In some patients, both tests should be done.

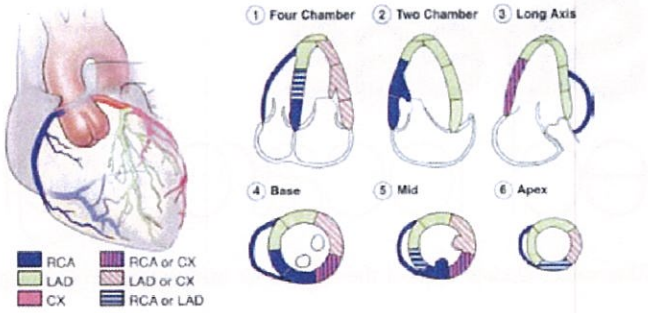


FIGURE 1
American Society of Echocardiography 16-segment model.
RCA = right coronary artery, LAD = left anterior descending artery, CX = circumflex artery.

Clinical utility

The sensitivity and specificity of stress echo for detection of coronary disease (as arbitrarily defined on invasive angiography) is up to 97% (mean of 88%) and up to >90% (mean of 79%), respectively, and varies with the pre-test probability of the populations being studied. These sensitivities and specificities are superior to a plain exercise stress ECG and are comparable with nuclear medicine techniques. The problem of false-positive stress ECGs in low-risk women is overcome.

To become preoccupied with a comparison with the imperfect gold standard of invasive angiography and perceived 'shortcomings' is to fail to appreciate the contribution of functional imaging in general, and stress echo in particular. Ultimately, the aim of any test in cardiology is not to predict an invasive angiogram result, but rather, to predict death and clinically important cardiovascular endpoints such as myocardial infarction and angina. Especially in the post-COURAGE trial era, accurate determination of the presence or absence of angina is crucial. Functional testing can do this, whereas coronary angiography cannot.

Another aim of testing is to predict the impact of therapies, such as stenting, on death and cardiovascular events. Stress echo has proven prognostic power. A negative test gives the reassurance of an annual rate of ≤0.5% per year for at least the next five years, a rate so low that no therapy is likely to have a clinically meaningful impact.

Research has demonstrated that the high accuracy of stress echo can only be achieved with specific training of both the cardiologist/sonographer acquiring the images and the cardiologist reporting the study.

Stress echo is particularly preferred for patients for which a stress ECG has reduced accuracy, for example, for women (who have a high false-positive rate with stress ECG); and patients with hypertension; left ventricular hypertrophy; left or right bundle branch block; T-wave inversion on resting ECG; or digoxin use. A good rule of thumb is that any patient with an abnormal resting ECG is not suitable for a stress ECG, but should undergo an imaging stress test such as a stress echo. Unlike stress ECG, stress echo has been validated for the detection of ischaemia in patients with previous revascularisation.

A major advantage of stress echo over nuclear techniques and coronary angiography (invasive or CT) is the absence of radiation. From a single 14.7 mSv CT coronary angiogram, the lifetime risk of cancer for a 20-year-old female is almost one per cent (one in 143). The average radiation doses for a sestamibi study, invasive coronary angiography and coronary stenting are 8, 5.6 and 14-15 mSv respectively. The danger is compounded when patients are subjected to serial studies and procedures over the course of their lifetime.

Stress echo has several other advantages over nuclear techniques: no breast attenuation artefact; quicker; less expensive; useful ancillary information on valves, etc.

THE CARDIOLOGIST'S ROLE

Stress echo is reported by a cardiologist. Cardiologists understand the clinical significance of the pathology they report. They are able to expertly integrate the clinical information with the results of the test. They understand that the role of any imaging service or, for that matter, any diagnostic service, is to provide a service to the referrer. This means understanding the clinical questions being asked by the referrer and those generated by any pathology detected (whether it was suspected or is incidental) and then providing a report that assists the referring clinician to answer those questions and make clinical decisions with respect to management.

Cardiologists are themselves in the position of receiving stress test reports of all kinds and discharging the clinical responsibility that comes with this situation. In cases where GPs refer patients for stress echo alone (without a clinical consultation), the reporting cardiologist will, if appropriate, provide useful clinical comments to guide management, in addition to reporting the test.

If, on the basis of the test results, the cardiologist is of the opinion that it is appropriate that the patient have a formal clinical consultation with a cardiologist, then it is standard practice to state this as a comment on the report. The cardiologist is in a position to be personally available for the clinical consultation (unlike nuclear medicine doctors). In this situation, there are advantages in referring the patient to the cardiologist who reported the stress echo. It is also quite reasonable to refer the patient to another cardiologist, as there may be other relevant factors to be considered in making the choice.

It is reasonable for GPs to refer patients directly for stress echo without the patient seeing a cardiologist for a clinical consultation beforehand, just as it is reasonable for GPs to refer patients directly for any form of stress testing. In these situations, on receiving a stress echo report, a GP may then decide to refer the patient for a clinical consultation with a cardiologist. Neither the patient nor the cardiologist is usually disadvantaged in these cases.

Interpreting the report

In most cases, a GP need not look any further than the conclusions. Most outpatient studies will be reported as 'normal'.

Because of the lower false-positive rate than either stress ECG or nuclear studies, more stress echocardiograms than these competing technologies will come back with 'normal' reports, making life easier for the referring GP.

NO INDUCIBLE WALL MOTION ABNORMALITIES

The next most common conclusion will be 'no inducible wall motion abnormalities' or 'no inducible ischaemia'.

Neither of these conclusions has exactly the same meaning as each other or as 'normal'.

Recall that the stress echo detects ischaemia by identifying hypokinesis (also known as abnormal wall motion) when the heart is in the exercise or 'stressed' state.

'No inducible wall motion abnormalities' literally means specifically that there was no abnormal wall motion in the stressed state.

The usual reason the cardiologist will opt for the conclusion 'no inducible wall motion abnormalities' rather than 'normal' is when the patient experiences chest discomfort during stress. This chest discomfort may or may not be angina. It is unusual but possible that patients experience angina in the absence of inducible wall motion abnormalities.

The doctor supervising the stress echo assesses the chest discomfort and decides whether or not it is angina. This is a clinical assessment. There is an obvious advantage in these situations if the doctor supervising the stress echo is also the cardiologist reporting the study.

The assessment and management of patients with true angina and no inducible wall motion abnormalities is complex advanced cardiology. Rather than being a waste of time, the stress echo in such patients is particularly useful as it stratifies their prognosis and guides management.

It is a recognised phenomenon for