Functional cardiac testing in the diagnosis and management of coronary artery disease

Cost-effectiveness of functional cardiac testing in the diagnosis and management of coronary artery disease: a randomised controlled trial. The CECaT trial

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Executive summary

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Executive summary

Objectives

The objectives of this trial were to assess the following:

- acceptability and feasibility of functional tests as a gateway to angiography for the management of coronary artery disease (CAD)
- ability of diagnostic strategies to identify patients who should undergo revascularisation
- patient outcomes in each diagnostic strategy
- the most cost-effective diagnostic strategy for patients with suspected or known CAD.

Setting

The setting was Papworth Hospital NHS Foundation Trust, a tertiary cardiothoracic referral centre.

Participants

The trial participants were patients with suspected or known CAD and an exercise test result that required non-urgent angiography.

Exclusion criteria were: recent myocardial infarction or revascularisation, admission with chest pain; urgent revascularisation; contraindication to pharmacological stress testing on magnetic resonance imaging (MRI); incapable of performing modified Bruce exercise test; not available by telephone.

Interventions

Patients were randomised to one of four initial diagnostic tests: angiography (controls); single photon emission computed tomography (SPECT); MRI; stress echocardiography.

Main outcome measurements

The main outcome measurements were as follows:

- Primary: at 18 months post-randomisation: exercise time (modified Bruce protocol); cost-effectiveness compared with angiography (diagnosis, treatment and follow-up costs). The aim was to demonstrate equivalence in exercise time between those randomised to functional tests and those randomised to angiography [defined as the confidence interval (CI) for mean difference from angiography within 1 minute].
- Secondary: exercise time at 6 months post-treatment; successful completion of initial diagnostic test; Canadian Cardiovascular Society (CCS) classification of angina; health-related quality of life (HRQoL) measured by the Seattle Angina Questionnaire, the Short Form with 36 Items and the EuroQoL; revascularisation rate; adverse events; clinician confidence in test results.

Results

Between September 2001 and September 2004, 898 patients were randomised to angiography (n = 222), SPECT (n = 224), MRI (n = 226) or stress echo (n = 226). There were no significant differences between the groups at baseline. At 18 months, compliance was 86% for the full protocol and 94% for cost-effectiveness data.

Initial diagnostic tests were completed successfully with unequivocal results for 98% of angiography, 94% of SPECT (p = 0.05), 78% of MRI (p < 0.001) and 90% of stress echocardiography patients (p < 0.001).

Some 22% of SPECT patients, 20% of MRI patients and 25% of stress echo patients were not subsequently referred for an angiogram. Positive functional tests were confirmed by positive angiography in 83% of SPECT patients, 89% of MRI patients and 84% of stress echo patients. Negative functional tests were followed by positive angiograms in 31% of SPECT patients, 52% of MRI patients and 48% of stress echo patients tested.

The proportions who had coronary artery bypass graft (CABG) surgery were 10% (angiography), 11% (MRI) and 13% (SPECT and stress echo) and percutaneous coronary intervention (PCI) 25% (angiography), 18% (SPECT) and 23% (MRI and stress echo).

At 18 months, comparing SPECT and stress echo with angiography, a clinically significant difference in total exercise time can be ruled out. The MRI group had significantly shorter mean total exercise time of 35 seconds and the upper limit of the CI was 1.14 minutes less than in the angiography group, so a difference of at least 1 minute cannot be ruled out.

At 6 months post-treatment, SPECT and angiography had equivalent mean exercise time. Compared with angiography, the MRI and stress echo groups had significantly shorter mean total exercise time of 37 and 38 seconds, respectively, and the upper limit of both CIs was 1.16 minutes, so a difference of at least 1 minute cannot be ruled out. The differences were mainly attributable to revascularised patients.

There were significantly more non-fatal adverse events in the stress echo group [rate relative to angiography: 1.95 (95% CI: 1.23 to 3.08), $p = 0.012$], mostly admissions for chest pain, but no significant difference in the number of patients reporting events [1.59 (95% CI: 0.90 to 2.79), $p = 0.327$].

There was no significant difference among the groups in CCS class at either assessment. Clinically important differences in HRQoL could be ruled out.

Mean (95% CI) total additional costs over 18 months, compared with angiography, were £415 (–£310 to £1084) for SPECT, £426 (–£247 to £1088) for MRI and £821 (£10 to £1715) for stress echocardiography, with very little difference in quality-adjusted life-years (QALYs) amongst the groups (less than 0.04 QALYs over 18 months). Cost-effectiveness was mainly influenced by test costs, clinicians' willingness to trust negative functional tests and by a small number of patients who had a particularly difficult clinical course.

Conclusions

Between 20 and 25% of patients can avoid invasive testing using functional testing as a gateway to angiography without substantial effects on outcomes. The SPECT strategy was as useful as angiography in identifying patients who should undergo revascularisation. The additional cost for the SPECT strategy was not significant and would be reduced further by restricting the rest test to patients who have a positive stress test.

MRI had the largest number of test failures and, in this study, had the least practical use in screening patients with suspected CAD, although it had similar outcomes to stress echo. This technology and decision rules for its interpretation are still evolving.

Stress echo patients had a 10% test failure rate, significantly shorter total exercise time and time to angina at 6 months post-treatment, and a greater number of adverse events, leading to significantly higher costs. Much of the excess costs were attributable to a small number of patients with particularly difficult clinical courses, unrelated to the diagnostic strategy. Given the level of skill required for stress echo, it may be best to reserve this test for those who have a contraindication to SPECT and are unable or unwilling to have MRI.

Implications for the NHS

Functional testing has a place in the diagnostic pathway for the assessment of chest pain in an outpatient population, avoiding invasive tests in a significant proportion of patients. The choice of test may be determined by local expertise and evolution of MRI. In this study, SPECT had the best outcomes, reflecting the greater experience of using this technique, although most differences between the tests were minor and there is a place for all three.

Recommendations for future research

Further research, using blinded reassessment of functional test results and angiograms, is required to formally assess diagnostic accuracy.

Longer-term cost-effectiveness analysis should assess whether decisions based on the functional tests have significant impact in the longer term.

Further studies of MRI and new generation computed tomography are required.

Publication

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