Exercise echocardiography or exercise SPECT imaging: a meta analysis of diagnostic test performance

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Authors' objectives
To assess the diagnostic performance of exercise echocardiography (ECHO) and exercise single-photon emission computed tomography (SPECT) imaging in the diagnosis of coronary artery disease (CAD).

Searching
MEDLINE was searched from January 1970 to October 1997 using the keywords 'coronary disease' and 'exercise test' in conjunction with 'echocardiography', 'thallium', 'thallium radioisotopes', or 'sestamibi', and restricted by the term 'human'. The authors also searched the bibliographies of reviews and original articles and elicited suggestions for additional information from experts in the field.

Study selection
No inclusion criteria relating to the study design were specified.

Specific interventions included in the review
Studies of exercise ECHO and/or exercise SPECT imaging with thallous chloride TL201 (thallium) or technetium Tc 99m sestamibi were eligible for inclusion.

Reference standard test against which the new test was compared
Studies that used coronary angiography as the reference test to diagnose CAD were included.

Participants included in the review
Patients undergoing diagnosis for CAD. Studies performed exclusively in patients after myocardial infarction (MI), percutaneous transluminal coronary angioplasty, coronary artery bypass grafting, or with recent unstable coronary syndromes, were excluded. The weighted mean age of the participants in the ECHO studies was 59 years and 69% were male; 66% of the patients presented with significant CAD and 20% with prior MI. The weighted mean age of the participants in the SPECT studies was 59 years and 70% were male; significant CAD was present in 78% of the patients and prior MI in 53%. The weighted mean age of participants in the exercise ECHO and/or exercise SPECT studies where exercise electrocardiogram (ECG) results were also given was 59 years and 66% were male; significant CAD was present in 69% of the patients and prior MI in 20%.

Outcomes assessed in the review
Studies had to report the absolute numbers of true-positive, false-negative, true-negative and false-positive observations to be included. The outcomes reported in the review were the sensitivity, specificity and summary receiver operating characteristic (ROC) curves.

How were decisions on the relevance of primary studies made?
The authors did not state how the papers were selected for the review, or how many reviewers performed the selection.

Assessment of study quality
The authors did not state that they assessed validity.

Data extraction
Two reviewers independently extracted the data onto a standardised spreadsheet. Any discrepancies were resolved by consensus.
Data were extracted for the categories of clinical variables, technical factors and test performance. If the articles reported sensitivity and specificity data for important patient subsets, such as patients with multi-vessel disease, these data were extracted separately. If several types of tests were assessed in the same report, data on test performance were extracted for each. The likelihood of verification bias was assessed by noting whether the decision to proceed to the reference test (contrast angiography) was, in part, dependent on the results of the noninvasive test.

Methods of synthesis
How were the studies combined?
The pooled sensitivity and specificity, along with 95% confidence intervals (CIs), were calculated using a fixed-effect model. The authors used summary ROC analysis for each test separately and then together to directly compare the individual tests (exercise ECHO with exercise SPECT, exercise ECHO with exercise ECG, and exercise SPECT with exercise ECG).

How were differences between studies investigated?
Final summary ROC models were tested for heterogeneity by comparing the values predicted by the model with the 95% CI of the actual values for each article. Explanatory variables (e.g. publication year, proportion of patients with prior MI, mean age, proportion of men, presence of verification bias) were addressed and included in the analysis where significant.

Pooled weighted results were also generated for important patient subsets such as patients with prior MI and patients with severe CAD. The authors also explored the effect of varying positivity criteria on the pooled results. In addition, exercise ECHO studies were grouped as requiring either new regional wall motion abnormalities (RWMAs) or new or worse RWMAs.

Results of the review
Forty-four studies, which were separated into three groups, were included in the review. Twenty-four studies reported exercise ECHO results for 2,637 patients; 27 studies reported exercise SPECT results for 3,237 patients; 24 studies reported exercise ECHO and/or exercise SPECT results for 2,456 patients where data on exercise ECG were also given.

The analyses were homogeneous with the exception of one study that compared exercise SPECT with either exercise ECHO or exercise ECG in the overall cohort, and which was likely related to the very high sensitivity (97%) reported in this cohort with one specific SPECT imaging filter. Two other studies comparing exercise ECHO with exercise SPECT (ECHO data from one study and SPECT data from the second) study both showed very high sensitivity and fell outside predicted values.

Exercise ECHO had a pooled sensitivity of 85% (95% CI: 83, 87) with a specificity of 77% (95% CI: 74, 80). Exercise SPECT had a pooled sensitivity of 87% (95% CI: 86, 88) with a specificity of 64% (95% CI: 60, 68).

In a summary ROC model comparing exercise ECHO performance with exercise SPECT, exercise ECHO was associated with significantly better discriminatory power (parameter estimate 1.18, 95% CI: 0.71, 1.65) when adjusted for age, publication year, and a setting including known CAD for SPECT studies.

In models comparing the discriminatory abilities of exercise ECHO and exercise SPECT versus exercise testing without imaging, both ECHO and SPECT performed significantly better than exercise testing. The incremental improvement in performance was greater for ECHO (3.43, 95% CI: 2.74, 4.11) than for SPECT (1.49, 95% CI: 0.91, 2.08).

Authors’ conclusions
Exercise ECHO and exercise SPECT have similar sensitivities for the detection of CAD, but exercise ECHO has better specificity and, therefore, higher overall discriminatory capabilities as used in contemporary practice.
CRD commentary
The authors clearly stated their research question and inclusion and exclusion criteria. The literature search was good, but the authors may have missed studies published outside the USA by restricting the searches to MEDLINE and English language publications. There was also no attempt to identify unpublished studies or to assess the possibility of publication bias. The quality of the included studies was not formally assessed and the authors did not provide details of how the articles were selected and how many reviewers were involved, or on the specific design of the included studies.

The data extraction was reported in the text and in tabular format. The statistical pooling was appropriate and there were tests for heterogeneity. The authors discussed several methodological and data limitations in the review.

The authors’ conclusions appear to follow from the results, but should be viewed with caution because of the methodological limitations of the review.

Implications of the review for practice and research
The authors did not state any implications for practice or further research.

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Other publications of related interest
This additional published commentary may also be of interest. Jacobs M. Review: exercise ECHO is a more specific and discriminatory test than exercise SPECT for coronary artery disease. ACP J Club 1999;130:45.

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This is a critical abstract of a systematic review that meets the criteria for inclusion on DARE. Each critical abstract contains a brief summary of the review methods, results and conclusions followed by a detailed critical assessment on the reliability of the review and the conclusions drawn.