Evaluation of aortic valve stenosis by cardiac multislice computed tomography compared with echocardiography: a systematic review and meta-analysis

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CRD summary
This review assessed the performance of cardiac multi-slice computed tomography (CT), compared with echocardiography, for evaluation of aortic valve stenosis and detection of coronary artery disease; it concluded that multi-slice CT was reliable for the quantification of aortic valve area and promising for coronary artery disease detection. The review had methodological limitations, but the authors' conclusions were appropriately cautious.

Authors' objectives
To assess the diagnostic performance of cardiac multi-slice computed tomography (CT) compared with standard echocardiography for the evaluation of aortic valve stenosis. A secondary objective of the review was to assess the accuracy of multi-slice CT in diagnosing significant coronary artery stenosis.

Searching
PubMed, EMBASE and the Cochrane Library were searched to May 2009, with no language or date restriction. Search terms were reported. Meeting abstracts were searched in Web of Science. Bibliographies of retrieved articles were screened for additional studies. Inclusion was restricted to studies published in full, although in-press articles that were pre-published on-line were eligible.

Study selection
Studies that evaluated multi-slice CT (16-slice or more) in patients with aortic valve stenosis were eligible for inclusion. Eligible studies had to use transthoracic echocardiography or transoesophageal echocardiography as the reference standard and report the aortic valve area. Studies that evaluated multi-slice CT for the detection of significant coronary artery stenosis (50% or more reduction in diameter) in patients with aortic valve stenosis, and used invasive angiography as the reference standard were also eligible for inclusion. Studies of patients with prosthetic valves were excluded.

Included studies of multi-slice CT for the assessment of aortic valve stenosis used 16-, 40- or 64-slice CT. In most included patients, aortic valve area was determined using transthoracic echocardiography. Included studies were of patients with known aortic valve stenosis, undergoing cardiac surgery, referred for cardiac multi-slice CT, or those who were candidates for aortic valve replacement. Mean participant age ranged from 62 to 74.5 years; most participants were male (where reported).

Included studies of multi-slice CT for the detection of significant coronary artery stenosis used 16- or 64-slice CT.

Two reviewers independently screened studies for inclusion and any disagreements were resolved by a third reviewer.

Assessment of study quality
The authors did not state that they assessed the methodological quality of included studies.

Data extraction
Mean and standard deviation aortic valve area measurements and the numbers of true positives, false negatives, false positives and true negatives for the detection of aortic valve stenosis, bicuspid valve and coronary artery stenosis, were extracted where possible. If published data were insufficient or unclear, corresponding authors were contacted.

Data were independently extracted by two reviewers; any disagreements were resolved by consultation with a third reviewer.

Methods of synthesis
Meta-analyses (both random-effects and fixed-effect models) were used to estimate the weighted mean difference in aortic valve area (measured by multi-slice CT versus transthoracic echocardiography/transoesophageal echocardiography). The Bland-Altman test was used to assess agreement between multi-slice CT and transthoracic echocardiography/transoesophageal echocardiography measurements; agreement limits with ±1.96 standard deviation and 95% confidence intervals (CIs) were calculated.

Pooled estimates of the sensitivity, specificity and diagnostic odds ratio (DOR), with 95% confidence intervals, of multi-slice CT for the detection of aortic valve stenosis, bicuspid valve and coronary artery stenosis were calculated.

Between study heterogeneity was assessed using the $\chi^2$ and $I^2$ tests.

Publication bias (among studies reporting aortic valve area) was assessed using the Egger and Begg tests.

**Results of the review**
Seventeen studies were included in the review (with 674 patients). Fourteen studies (n=509 patients) reported data on aortic valve area/aortic valve stenosis. Seven studies (n=266 patients) reported data on coronary artery stenosis (four studies reported data for both applications).

**Aortic valve area**: Multi-slice CT overestimated aortic valve area, with a bias of 0.08 cm$^2$ (95% CI 0.04 to 0.13; $p=0.0001$), compared with transthoracic echocardiography (14 studies, n=470 patients), but multi-slice CT measurement of aortic valve area was concordant with transoesophageal echocardiography (four studies, n=168 patients). There was no evidence of statistically significant between study heterogeneity in either analysis.

**Coronary artery stenosis**: The pooled estimate of the sensitivity of multi-slice CT for the detection of 50% coronary artery stenosis or more was 95.5% (95% CI 88 to 99%) and the pooled estimate of specificity was 81% (95% CI 75 to 86%); the pooled diagnostic odds ratio was 53 (95% CI 19 to 147).

**Aortic valve stenosis**: The pooled estimate of the sensitivity of multi-slice CT for the detection of severe aortic valve stenosis (where transthoracic echocardiography was the reference standard) was 92% (95% CI 85 to 96%) and the pooled specificity was 94% (95% CI 86 to 98.5%); the pooled diagnostic odds ratio was 170 (95% CI 15 to 1,967; four studies, n=162 patients).

**Bicuspid aortic valve**: The pooled estimate of the sensitivity of multi-slice CT for the detection of bicuspid aortic valve (where transthoracic echocardiography was the reference standard) was 89% (95% CI 84 to 93; six studies, n unclear); reported data were insufficient to calculate specificity and diagnostic odds ratio.

**Authors' conclusions**
Multi-slice CT was a reliable method for the quantification of aortic valve area, and represented a promising technique for the combined evaluation of aortic valve morphology and coronary artery disease.

**CRD commentary**
This review addressed two clearly stated research questions, defining appropriate inclusion criteria for both. A number of sources were searched for relevant studies, with no language restrictions. However, inclusion was restricted to published studies and the methods used to assess publication bias are unreliable in reviews of test accuracy studies, so publication bias could not be ruled out. Measures to minimise error and bias were reported throughout the review process.

No assessment of the methodological quality of included studies was reported, so the reliability of data included in the meta-analyses was uncertain. The meta-analyses applied to aortic valve area estimates appeared appropriate. The validity of pooled estimates of diagnostic accuracy could not be assessed, as no data were reported for individual included studies and the results of heterogeneity assessments were also omitted.

Given the limitations described, the authors' conclusions were appropriately cautious.
Implications of the review for practice and research

**Practice:** The authors stated that current multi-slice CT techniques may be used for diagnosis and quantification of aortic valve stenosis in selected patients in whom transthoracic echocardiography or transoesophageal echocardiography are inconclusive. Concomitant assessment of the aortic valve can be recommended in patients undergoing multi-slice CT for suspected coronary artery disease. Current multi-slice CT techniques cannot be recommended for the routine diagnosis or screening of patients with suspected aortic valve stenosis.

**Research:** The authors stated that trials on aortic valve assessment by new techniques (e.g. 320 multi-slice CT) are needed.

**Funding**
Not stated.

**Bibliographic details**

**PubMedID**
20099712

**Original Paper URL**
http://www.icr-heart.com/journal/content/2009/nov/abstracts/article.php?id=399

**Indexing Status**
Subject indexing assigned by NLM

**MeSH**
Angiography; Aortic Valve Stenosis/radiography/ultrasonography; Echocardiography; Humans; Tomography, X-Ray Computed

**AccessionNumber**
12010001326

**Date bibliographic record published**
15/09/2010

**Date abstract record published**
16/03/2011

**Record Status**
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.