Head-to-head comparison of prospectively triggered vs retrospectively gated coronary computed tomography angiography: meta-analysis of diagnostic accuracy, image quality, and radiation dose

Menke J, Unterberg-Buchwald C, Staab W, Sohns JM, Seif Amir Hosseini A, Schwarz A

CRD summary
This generally well-conducted review concluded that patients with coronary artery disease without an abnormally fast heart rate had comparable image quality and diagnostic accuracy with prospectively triggered and retrospectively gated computed tomography angiography. A lower radiation dose was associated with the prospectively triggered. The conclusions are likely to be reliable.

Authors' objectives
To compare prospectively triggered and retrospectively gated coronary computed tomography angiography (CTA) for image quality, diagnostic accuracy and radiation dose, in patients with suspected or known coronary artery disease.

Searching
PubMed, Scopus, Biosis Previews and Web of Science were searched without language restrictions for published studies from 2007 to September 2012; the PubMed search strategy was reported. Reference lists of retrieved articles were also searched.

Study selection
Studies that compared prospectively triggered and retrospectively gated CTA in terms of image quality, diagnostic accuracy, or radiation dose in at least 10 patients with suspected or known coronary artery disease were eligible for inclusion. Studies also had to: recruit patients with similar characteristics and patient numbers into the two study groups; use at least a 64-slice single-source or 32-detector dual-source detector during the CTA; use a score applied at the segment and/or artery level (if assessing image quality); present sufficient data to construct 2x2 tables of test performance for detecting 50% or greater coronary stenosis (if assessing diagnostic accuracy); exclude patients whose heart rate exceeded 75 beats/min during coronary CTA, except when using a technology with a high temporal resolution; and report the mean effective radiation dose.

Most studies restricted inclusion with an upper heart rate limit of 65 to 75 beats/min. Studies excluded patients with non-sinus rhythm, renal insufficiency, contrast allergy, those unable to hold their breath and pregnant women. One third of studies included patients with stents. The prevalence of coronary artery disease ranged from 5% to 91%. Where reported, most studies administered beta-blockers and nitroglycerin when necessary.

Two reviewers independently selected studies for the review; disagreements were resolved by consensus.

Assessment of study quality
Study quality was assessed using a modified version of the 14-point QUADAS; two criteria were added - patient allocation to groups not biased and gating method unknown. For studies of image quality, 11 criteria were used with the criteria relating to the reference standard were omitted.

It appeared that two reviewers independently assessed study quality.

Data extraction
Count data for image quality and diagnostic accuracy were extracted on the segment level, artery level and patient level, where available. A 3-point score was applied for image quality (described in paper). The equations used to calculate radiation dose were reported. The effective dose was normalised to k=0.017, if another conversion factor had been used. Study authors were contacted for missing data.

Two reviewers independently extracted data; disagreements were resolved by consensus.
Methods of synthesis
Pooled percentages of diagnostic and non-diagnostic CTAs were calculated for image quality at a per patient and per segment level; mean quality scores were used to analyse data on a per artery level. A random-effects model was used. Subgroup analyses were performed at the segment level with the study characteristics as categorical covariates (actual covariates not specified). Pooled estimates of sensitivity and specificity were calculated using a bivariate random-effects model and a cutoff for a positive test of 50% stenosis. The meta-analysis of the effective radiation dose was performed on the logarithmic scale using a random-effects model. The risk of publication bias was assessed using the Deeks test.

Results of the review
Twenty studies met the inclusion criteria (3,442 patients; 3,330 were included in the meta-analysis); all reported imaging quality and five also reported diagnostic accuracy. Recruitment was prospective in 11 studies, retrospective in eight studies, and unclear in one study. Patient allocation was described in the review as randomised in eight studies, pseudorandom with sequential order in seven studies or with matching in three studies, and not reported in two studies. Most patients were enrolled consecutively. Study quality was considered to be generally high; studies that reported only image quality fulfilled 91% to 100% of the criteria, and five that reported diagnostic accuracy fulfilled 81% to 94%.

At the segment level (2,730 patients), there was no significant difference between prospective triggering and retrospective gating in terms of the proportion of non-diagnostic segments (2.2% versus 1.6% of segments); image quality was excellent in approximately 73% of segments for both technologies. There was also no significant difference between the two technologies at the artery (764 patients) or patient (2,655 patients) level.

In terms of diagnostic accuracy (664 patients), using catheter angiography as the reference standard, pooled sensitivity of CTA was 92.2% (95% CI 84.2 to 96.3) and specificity was 97.7% (95% CI 96.6 to 98.4) in segments of diagnostic quality using 50% stenosis as the cutoff. At the patient level, sensitivity was 97.8% (95% CI 95.3 to 99.0) and specificity was 93.6% (95% CI 87.9 to 96.7). In most studies no CTA was excluded because of low image quality. There was no significant difference between the two technologies when analysed separately at either level.

The average CTA scan length was approximately 14 to 15cm for both technologies. The pooled effective dose was lower with prospective triggering at 3.5mSv (95% CI 3.0 to 4.1), compared to 11.3mSv (95% CI 8.7 to 14.7) for retrospective gating.

No publication bias was observed. Results of subgroup analyses were also reported.

Authors' conclusions
In patients with coronary artery disease and without tachyarrhythmia, prospectively triggered coronary CTA provided image quality and diagnostic accuracy was comparable with that of retrospectively gated CTA, but at a much lower radiation dose.

CRD commentary
The authors addressed a clear research question with reproducible inclusion criteria. Several relevant sources were searched for published studies, but there was no specific search for unpublished studies. Each stage of the review was conducted in duplicate, which reduced the risk of error and bias.

Appropriate criteria were used to assess study quality, and the results were considered in the analysis. However, the results were reported only in summary form, so the reader was unable to determine which study was prone to which bias. Appropriate methods of synthesis were used, although there were an extremely large number of subgroup and sensitivity analyses conducted, and it is unclear which of these were decided a priori.

This was a generally well conducted review, and the results are likely to be reliable.

Implications of the review for practice and research
Practice: The authors stated that the reduced radiation dose required with prospectively triggered coronary CTA was relevant both to the physician performing the test and the referring clinician because both were responsible for the
patient’s protection against radiation and that must be weighed against the need for diagnostic information; the authors go on to state that it was favourable to choose the method with the lowest radiation exposure, if the results were similarly good. The authors also stated that although the triggering/gating method was by far the most relevant determinant of radiation dose, the other factors such as tube voltage, tube current, scan length and contrast medium injection should also always be optimised to obtain diagnostic images while keeping the radiation dose as low as reasonably achievable.

**Research:** The authors did not state implications for research.

**Funding**
None.

**Bibliographic details**

**PubMedID**
23351817

**DOI**
10.1016/j.ahj.2012.10.026

**Original Paper URL**

**Indexing Status**
Subject indexing assigned by NLM

**MeSH**
Coronary Angiography /methods /standards; Coronary Artery Disease /radiography; Humans; Prospective Studies; Radiation Dosage; Reproducibility of Results; Retrospective Studies; Tomography, X-Ray Computed

**AccessionNumber**
12013011860

**Date bibliographic record published**
07/03/2013

**Date abstract record published**
11/06/2013

**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.