

Dose reduction in coronary calcium scoring: the impact of iterative reconstruction combined with low tube voltage on calcium scores

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Purpose

To define a low-dose coronary calcium scan protocol including advanced dose reduction techniques yielding similar calcium score results as the conventional full-dose protocol.

Methods and Materials

A calcium insert with 100 small calcifications (size: 0.5-2.0 mm, density: 90-540 mgHA) was placed inside a anthropomorphic thorax phantom and was scanned with third generation dual-source CT, see [Fig. 1](#) on page 4. The reference protocol was 120 kVp at 90 reference (ref) mAs with filtered back-projection (FBP). The same ref mAs was used for acquisitions at 70, 80, 90, 100, 110 kVp, reconstructed with FBP and Advanced Modeled Iterative Reconstruction (ADMIRE), strengths 1 to 5. These 30 protocols were compared to the reference protocol, regarding: calcium detectability, calcium scores and image quality. For protocols that yielded similar calcium scores as the reference protocol, additional scans were acquired at reduced dose by lowering the quality reference mAs in 20% steps, to 72, 54, 36 and 18. By adding a medium and large fat ring to the thorax phantom, the impact of these dose reduced protocols were also evaluated for medium and large patient size. All acquisitions were repeated five times with a small translation and rotation between each scan. Independent-samples-median test was used to determine differences in contrast/signal to noise ratio (CNR and SNR), dose and calcium scores.

Images for this section:

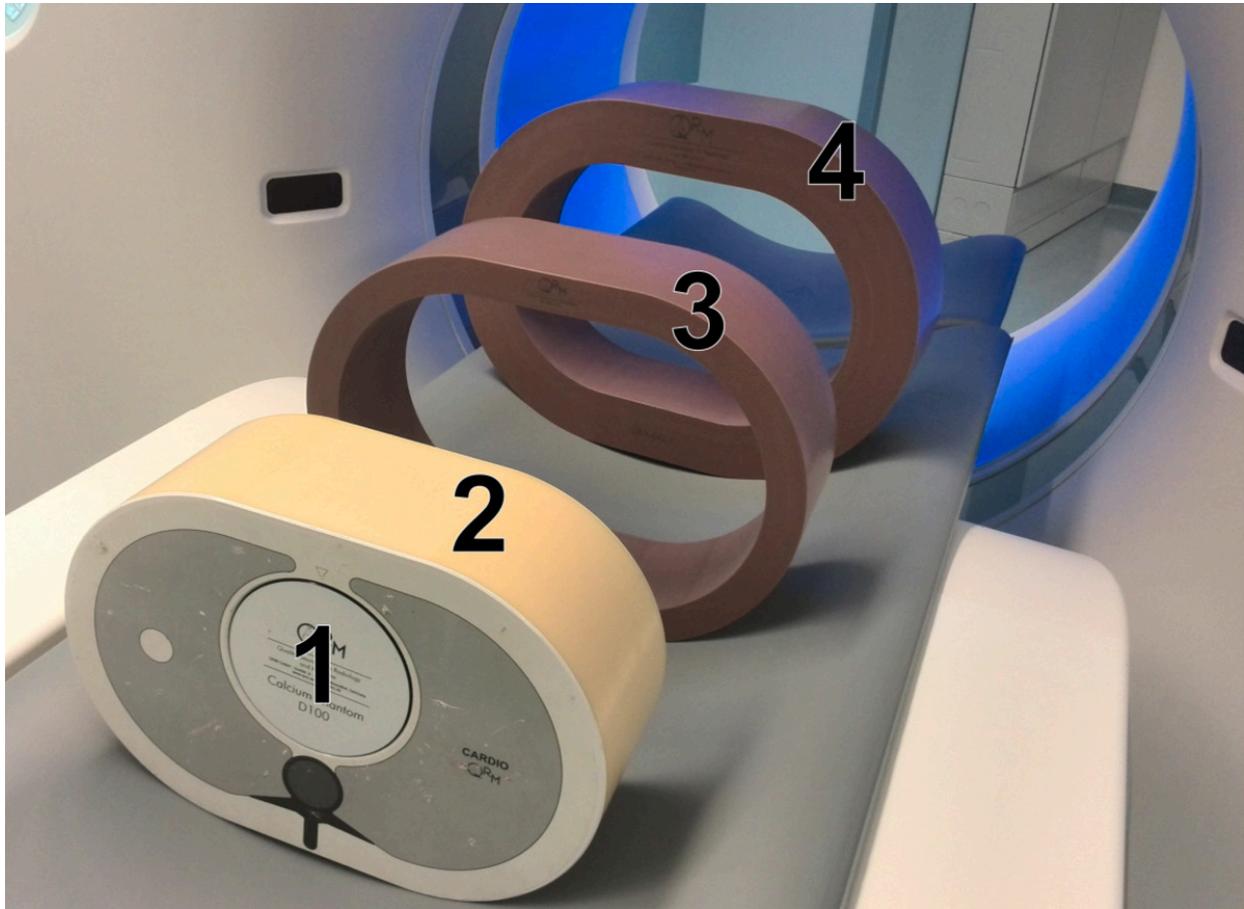


Fig. 1: Phantom set-up, containing (1) coronary calcium insert with (2) anthropomorphic thorax representing small patient size and additional phantomrings representing (3) medium and (4) large patient size.

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Results

Of the 30 protocols compared to the reference protocol, only 90kVp-ADMIRE3 and 100kVp-ADMIRE1 did not show any difference in detectability, Agatston score, volume score and mass score ($p>0.206$). Detectability and Agatston score were not affected by lower tube currents of 36-72 ref mAs with 90kVp-ADMIRE3 and 54-72 ref mAs with 100kVp-ADMIRE1 for small to large patient size ($p>0.206$), see [Fig. 2](#) on page 6, while the and CNR and SNR were similar or higher than the reference protocol ($0.008<p<0.206$). For the 100kVp-IR1 protocol with 52-74 ref mAs, also similar results for calcium volume and mass score as the reference protocol were found ($p>0.206$), for all patient sizes. Dose could be reduced up to 60.6% and 43.6%, respectively, for 90kVp-ADMIRE3 and 100kVp-ADMIRE1.

Images for this section:

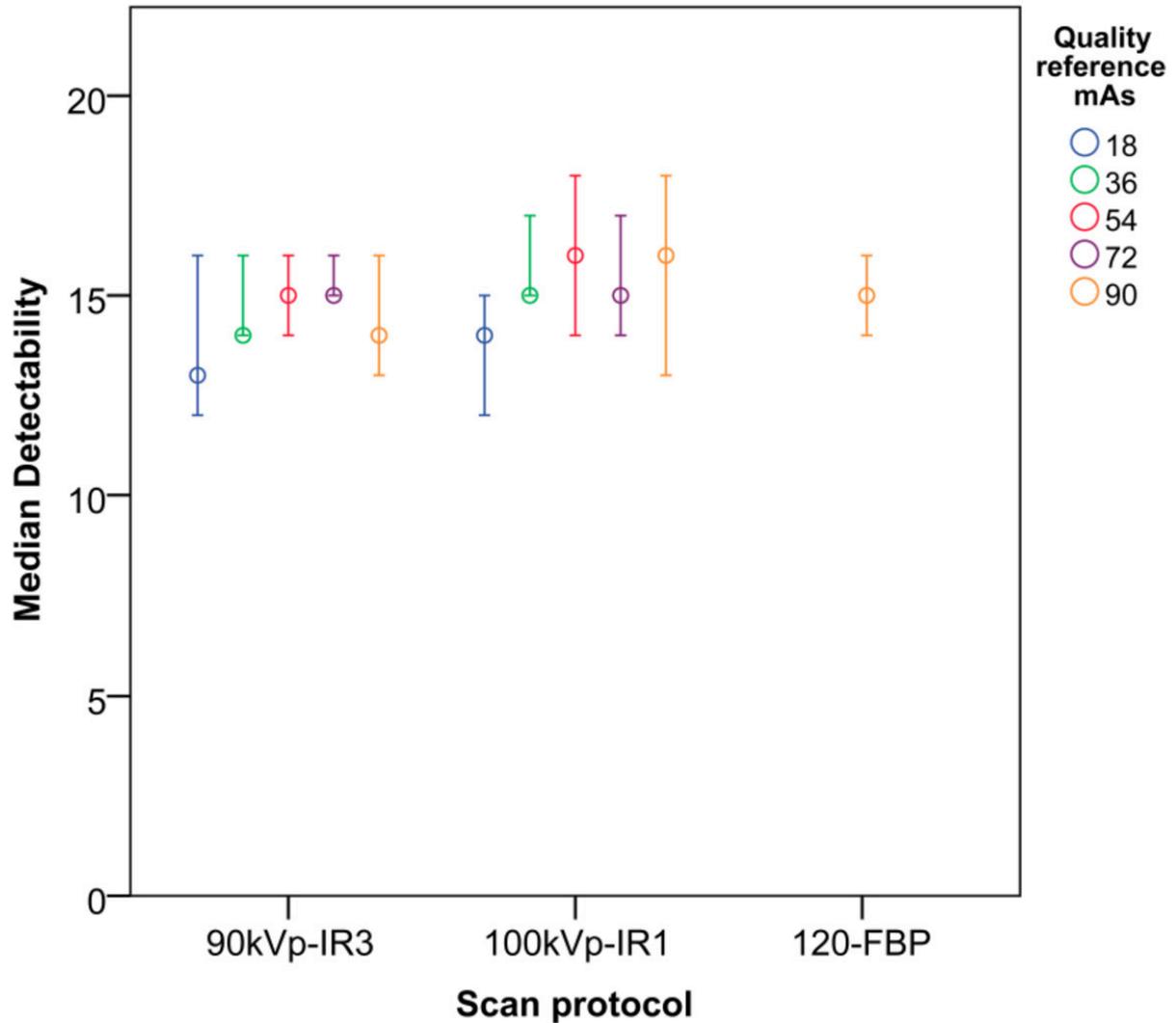


Fig. 2: Similar coronary calcium detectability was found for 90kVp-IR3 and 100kVp-IR1 compared to the reference acquisition of 120kVp-FBP, with minor impact of tube current (range 18-90 ref mAs).

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Conclusion

In this experiment, out of the 30 protocols, the combination of 90 kVp with ADMIRE strength 3 or 100 kVp with ADMIRE strength 1 yielded similar calcium detectability, Agatston score and image quality as conventional 120 kVp with FBP, with dose reduction up to 60.6%.