Computed tomography coronary angiography: Is radiation a concern for the gold standard test for anomalous coronary arteries?

Khaled Alfakih¹ and Sanjay Sharma¹,²

Abstract
Multi-detector computed tomography is now an established modality for the investigation of coronary artery disease² and has become method of choice, for the investigation of anomalous coronary arteries, in young patients/athletes with exertional chest pain or exercise-induced syncope. Anomalous coronary arteries, which have a prevalence of 0.3% in the general population, are found in up to 20% of autopsy series of sudden death in athletes (Figure 1). Exercise testing, particularly in athletes is often negative.¹ ³ MDCT provides three-dimensional images of the heart with excellent spatial resolution which demonstrate the coronary anatomy very clearly. MDCT is also a simple and fast test. However, there has been a concern about the radiation dose that these young patients would receive. When cardiac CT entered clinical practice in 2005, the radiation dose for a CT coronary angiogram was over 20 mSv. The technological developments in cardiac CT since have focused on dose reduction techniques. The first and still the most widely used technique, to lower the radiation dose, was the ECG controlled tube current modulation (ECTCM). It reduced the X-ray tube current during systole, when coronary motion is high and the images are mostly unhelpful, and reduced the radiation dose by 25%. However, this is not sufficient. Einstein et al.⁴ calculated the risk for future cancer from a CTCA with ECTCM (14 mSv) in a 20yr old woman, to be 1 in 219. Hence, it is critical to use all the additional dose reduction techniques now available, particularly in young patients. These include the use of the new iterative reconstruction technology to form the images, instead of the older filtered back projection, which reduces the radiation dose by 30%. This new technique, which also improves image quality, relies on the large computational capacity on the second generation 64 slice CT scanners. However, the most important way to lower the radiation dose is prospective ECG-triggering, where the acquisition is limited to a

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¹Lewisham University Hospital, London, UK
²St. George's Medical School, London, UK

Corresponding author:
Khaled Alfakih, Lewisham University Hospital, Lewisham High Street, London SE13 6LH, UK.
Email: khaled.alfakih@nhs.net
fraction of the cardiac cycle at end-diastole when coronary motion is minimal. This technique reduces the dose by 69%, but requires adequate β-blockade to slow the heart rate to 60 beats per minute. The radiation dose can still be reduced by a further 31%, by reducing the CT X-ray tube voltage from 120 to 100 KVp, for non-obese patients, without loss of image quality. Furthermore, as these mostly young/athletic patients are usually slim, they can be scanned at the even lower CT X-ray tube voltage of 80 KVp, reducing their dose by a further 30%. Utilising all the above techniques we have achieved radiation doses of 0.5 msv in our unit where we scan a number of young athletes (Figure 1). Finally, as it is just the origins of the coronary arteries that we are interested in, the length of the scan can be reduced to cover just the base of the heart, reducing the radiation dose even further.

Using all these techniques would ensure that cardiac CT is not just the best diagnostic test for anomalous coronary arteries but that it is also a very safe test and radiation is not generally a concern at such low doses. For comparison, the average dose for nuclear myocardial perfusion scan is 15.6 msv, CT of the abdomen is 8 msv, CT of the chest is 7 msv, a simple abdominal X-ray is 0.7 msv and the chest X-ray is 0.02 msv. It is critical that cardiologists and radiologists are both equally aware of the dose reduction techniques and that those techniques are utilised as much as possible particularly for patients being investigated for anomalous coronary arteries who are mostly young adults with a higher risk from radiation.

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References
1. Budoff MJ, Dowe D, Jollis JG, et al. Diagnostic performance of 64-multidetector row coronary computed tomographic angiography for the evaluation of coronary artery stenoses in individuals without known coronary artery disease. Results from the prospective multicentre ACCURACY trial. JACC 2008; 52: 1724–1732.
2. Meijboom WB, Meij MF, Schuijf JD, et al. Diagnostic accuracy of 64 slice computed tomography coronary angiography: a prospective multicentre multivendor study. JACC 2008; 52: 2135–2144.
3. Basso C, Maron BJ, Corrado D, et al. Clinical profile of congenital coronary artery anomalies with origin from the wrong aortic sinus leading to sudden death in young competitive athletes. *JACC* 2000; 35: 1493–1501.

4. Einstein A, Henzlova M and Rajagopalan S. Estimating risk of cancer associated with radiation exposure from 64-slice computed tomography coronary angiography. *JAMA* 2007; 298: 317–323.

5. Hausleiter J, Meyer TS, Martuscelli E, et al. Image quality and radiation exposure with prospectively ECG-triggered axial scanning for coronary CT angiography: the multicentre, multivendor, randomised PROTECTION-III study. *JACC Cardiovasc Imaging* 2012; 5: 484–493.

6. Hausleiter J and Martinoff S. Hadamitzky M, et al. Image quality and radiation exposure with a low tube voltage protocol for coronary CT angiography: results of the PROTECTION II Trial. *JACC Cardiovasc Imaging* 2010; 3: 1113–1123.

7. Fazel R, Krumholz HM, Wang Y, et al. Exposure to low dose ionizing radiation from medical imaging procedures. *NEJM* 2009; 361: 849–857.