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EDITORIAL COMMENT

100 kV versus 120 kV: effective reduction in radiation dose?

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Over the past few years, computed tomography (CT) angiography has emerged as a reliable non-invasive method for the assessment of coronary anatomy and cardiac function [1–17]. Multiple studies involving over several thousands of patients have established that CT angiography is highly accurate for delineation of the presence and severity of coronary atherosclerosis [18–35]. With its high negative predictive value cardiac CT is optimally suited for the evaluation of patients with a low or intermediate risk of coronary disease, allowing the non-invasive exclusion of coronary disease at relatively low cost and risk [36–48]. However, the appropriate radiation dose remains an important issue in cardiac CT. On one hand, a too low radiation dose may result in a high level of image noise and therefore in non-evaluable images. On the other hand, using higher radiation exposure levels may put patients at unnecessary risk of radiation damage [49–57].

The median exposure of CT angiography is approximately equivalent to 600 chest X-rays (12 mSv). Traditional angiography exposes patients to roughly half the dose of CT angiography. However, the radiation exposure of almost 2,000 people having 64-slice cardiac CT images at 50 medical centers in different countries may vary more than six-fold [58]. Effective strategies to reduce radiation dose, such as prospective gating, ECG-correlated modulation of the tube current, and tube voltage below 100 kV, are becoming more and more available.

In the current issue of the *International Journal of Cardiovascular Imaging*, Blankstein and coworkers [59] investigated the effective radiation dose and image quality of 100 kV versus 120 kV tube voltage among patients referred for cardiac dual source CT imaging. The authors collected prospective data on 294 consecutive patients. For each scan, a physician specializing in cardiac CT chose all parameters including tube current and voltage, axial versus helical acquisition, and use of tube current modulation. Lower tube voltage was selected for thinner patients or when lower radiation was desired for younger patients, particularly in females. For each study, image quality was rated on a subjective imaging quality score and contrast-to-noise and signal-to-noise ratios were assessed. Tube voltage of 100 kV was used for 77 (26%) exams while 120 kV was used for 217 (74%) exams. Use of 100 kV was more common in thinner patients. It was shown that the effective radiation dose for the 100 kV versus the 120 kV scans was significantly lower for the 100 kV scans: 8.5 and 15.4 mSv, respectively. Between the 100 and 120 kV scans, there was no

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differences in indication, use of beta-blocking agents, heart rate, scan length and use of radiation saving techniques such as prospective ECG triggering and tube current modulation. The imaging quality score was significantly higher for 100 kV scans. While 100 kV scans were found to have higher image noise then those utilizing 120 kV, the contrast-to-noise and signal-to-noise were significantly higher for the 100 kV scans. The authors concluded that in selected non-obese patients, the use of low voltage kV results in a substantial reduction of radiation dose and results in improved image quality. The study by Blankstein et al. [59] therefore suggests that low kV should be used more frequently in non-obese patients.

These findings are very interesting and may have direct implications in clinical practice. At present, there are serious concerns about radiation safety of cardiac CT images [60–64]. In a recent paper by Leschka et al. [62], it was shown that adjustment of the scan length of CT coronary angiography using the images from calcium scoring instead of the scout was associated with a 16% reduction in radiation dose of dual-source CT coronary angiography. In a large multicenter study of coronary CT angiography in patients with excellent heart rate control, Labounty et al. [63] reported that the use of minimal padding (i.e. additional surrounding X-ray beam on time), was associated with a substantial reduction in radiation dose together with preserved image interpretability. Recently, Rogalla et al. [64] recently showed that the anterior-posterior diameter adapted tube current in dynamic volume CT coronary angiography provided a new simple and practical approach to keep image quality constant by accounting for differences in patient size. Maintaining a constant image quality in CT, independent of patient body habitus, significantly contributed to a substantially improved diagnostic image quality together with a reduced radiation dose for the patient. Radiation exposure might be further decreased with 320-row MSTC scanners but further comparative studies are needed [65–67].

Generally, cardiac imaging tests should be used cautiously to minimize patient exposure to ionizing radiation. Cardiac imaging studies should be ordered only after thoughtful consideration of the potential benefits to the patient, thereby keeping in line with the established so-called 'appropriateness' criteria. As to CT angiography, Ayyad et al. [68] showed that the number of appropriate CT examinations increased from 69.5 to 78.5% during the period from 2006 to 2007, whereas the number of inappropriate examinations decreased from 11.5 to 4.6%. Interestingly, cardiologists were more likely than non-cardiologists to order CT examinations that were appropriate during the study period. However, a more recent study by Miller et al. [69] suggested that still a significant proportion (46%) of the coronary CT angiography studies are for indications not covered by the published appropriateness criteria. Adherence to the appropriateness criteria is of paramount importance in clinical practice. This policy will have a significant impact on physician decision making and patient care, such as exposure to a minimal radiation dose.

To summarize, in selected non-obese patients, Blankstein et al. [59] have convincingly demonstrated that use of low kV results in a substantial reduction of radiation dose without compromising image quality.

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