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EDITORIAL COMMENT

Low-dose CT angiography: sufficient contrast for vessel imaging?

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At present, noninvasive CT angiography has been shown to be as accurate as conventional angiography, and it had been presaged that CT angiography will soon be able to replace conventional coronary angiography [1–21]. The ACCURACY trial showed in 230 patients a 99% negative predictive value for CT angiography, establishing this method as an effective noninvasive alternative to conventional angiography to rule out obstructive coronary artery disease [22]. Despite the tremendous achievements by CT angiography, most investigators have called for restricted use of this imaging method until adequate clinical evidence becomes available showing the cost-effectiveness and safety of this approach. In particular, there are inherent questions about safety of cardiac CT scans in terms of radiation exposure [23, 24]. The median exposure of CT angiography is roughly 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 [25]. Effective strategies to reduce radiation dose are available but these strategies are not frequently used. The following strategies and new scanning techniques have been proposed for dose reduction in cardiac CT and include the following [26]: (1) coronary CT angiography should not be performed in patients with extensive coronary calcifications because the probability to rule out obstructive coronary artery disease diminishes with increasing coronary artery calcium scores; (2) the scan length in CT angiography should be individually adjusted to the minimum needed length; (3) electrocardiogram-correlated modulation of the tube current should be applied in all patients with stable sinus rhythm; (4) the tube voltage should be reduced to 100 kV in non-obese patients (patient weight <85–90 kg); and (5) a sequential scan mode with prospective electrocardiogram triggering should be considered in patients with a stable heart rate <or = 63 beats/min. Pflederer et al. [27] compared the image quality of dual-source CT coronary angiography using 100 kV instead of 120 kV in 100 patients. The authors showed that the use of lower tube voltage resulted in significant reduction in radiation exposure in noninvasive coronary CT angiography. Gopal et al. [28] showed in 149 patients using a 64-slice CT scanner that the combination of prospective ECG-triggered acquisition and 100 kV images were of diagnostic quality, allowing adequate assessment in all patients. The prospective ECG-Triggered acquisition and 100 kV

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images were of diagnostic quality, allowing adequate assessment in all patients. Steigner et al. [29] evaluated the relationship between the phase window width and image quality in prospectively ECG-gated 320-detector row coronary CT angiography. The authors showed that, using prospectively ECG-gated single heart beat coronary CT angiography, a phase window width of 10% reduced patient radiation and yielded diagnostic images in >90% of patients. Heart rate control proved to be an important component of 320-detector row prospectively gated CT dose reduction.

In the present study in the *International Journal of Cardiovascular Imaging*, Herzog et al. [30] evaluated 70 patients using prospectively ECG-triggered CT coronary angiography to establish the determinants of vessel contrast. All patients underwent low-dose CT angiography using body mass index (BMI)-adapted tube parameters and a fixed contrast material bolus. Mean radiation dose was 2.13 ± 0.69 mSv. Tube voltage had been adapted to patients' body mass index in order to minimize the interference of body mass index with image noise and, thus, contrast to noise ratio. With this strategy it was aimed at assessing the impact of cardiac output as an index of contrast bolus dilution on coronary artery attenuation and contrast to noise ratio. It was shown that a BMI adapted protocol widely reduced the impact of BMI on image noise, while vessel contrast remained subject to large variations, depending on bolus dilution by blood volume and cardiac output. The use of a BMI-adapted scanning protocol allowed the reduction of BMI interference on image noise as evidenced by similar noise values over a large range of BMI. Finally, the study identified body surface area as the most promising parameter to be of potential value for adjusting the contrast bolus in future protocols. As such, the present study by Herzog et al. [30] supports the notion that reduction of radiation exposure through low-dose CT angiography with prospective gating allows for proper vessel contrast using contrast dosages based on body surface area. These findings are in line with the recent findings of the same group guided by Kaufmann et al. [31, 32]), who showed that prospective ECG-triggering for CT angiography reduces radiation dose by almost 90% without affecting diagnostic performance. Consequently, striving for effective strategies to reduce radiation exposure—as well as implementing these strategies—are of paramount importance when evaluating patients undergoing CT angiography.

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