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EDITORIAL COMMENT

Increased accuracy in computed tomography coronary angiography; a new body surface area adapted protocol

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Amongst the advanced cardiac imaging modalities, multi detector computed tomography coronary angiography (CTCA) has emerged as a reliable non-invasive method for the assessment of coronary anatomy, coronary artery disease, and cardiac function [1–16]. Multiple studies involving over several thousands of patients have established that CTCA is highly accurate for delineation of the presence and severity of coronary atherosclerosis [9, 17–29]. CTCA may also reveal the total plaque burden, i.e., both calcified and non-calcified components, for individual patients with coronary atherosclerosis [30–39].

The advent of prospectively gated acquisition techniques for 64-slice CTCA has allowed a significant reduction in dose exposure [40–43]. Consequently, a combined approach of CTCA and myocardial perfusion imaging with CTCA angiography might potentially become feasible at a total radiation dose of much less than 10 mSv, particularly for the assessment of patients with established coronary artery disease, who are likely to have diffuse calcification [44–52]. In routine CTCA acquisitions, there might be a considerable signal density drop at the posterobasal wall resembling perfusion defects possibly being attributed to beam hardening artifacts [53] Beam hardening artifacts may be a common finding at CTCA of asymptomatic patients affecting predominantly the posterobasal wall, reducing the accuracy of CTCA. Also coronary vessel attenuation may affect the accuracy of CTCA as for an accurate detection of coronary plaque an appropriate amount of contrast material is needed. Coronary blooming artifacts caused by too large contract material amounts may hamper the detection of coronary plaque. The attenuation of coronary vessels is influenced by the individual patient's weight and height which are expressed by body mass index and body surface area (BSA) Attenuation of coronary vessels in CTCA is closely related to several factors including both patient specific characteristics such as body mass, blood volume and cardiac output and protocol-related parameters such as concentration and injection rate of the administered contrast material.

In patients with increased body mass CTCA image quality is degraded by an unfavorable shift in the signal-to-noise ratio due to increase in noise and loss of attenuation. Introduction of scan protocols with body mass index-adapted tube current and voltage have allowed handling the adverse effects of body mass on image noise. Therefore, BSA would be the most promising parameter to be used for contrast protocol adjustment. An ideal protocol should integrate both body mass index adaptation of tube

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parameters (noise minimization) and contrast material adjustment according to BSA (signal optimization). This may help differentiating coronary plaque from surrounding tissue and avoid blooming artifacts caused by intracoronary contrast material concentration. In patients with a large total blood volume, contrast material dilution decreases coronary attenuation in CTCA. In addition, increased blood volume is well paralleled by BSA.

In the current issue of the *International Journal of Cardiovascular Imaging*, Pazhenkottil et al. [54], using low-dose CTCA with prospective ECG-triggering, evaluated a BSA-adapted contrast material protocol to compensate for dilution effects in 80 patients with a BSA-adapted contrast material bolus ranging 40–105 ml and injection rate ranging 3.5–5.0 ml/s for a BSA of <1.70 m^2 to ≥ 2.50 m^2. A total of 80 controls matched for BSA who had previously undergone routine CTCA with a fixed contrast material protocol of 80 ml at 5 ml/s served as reference group. The average vessel attenuation from both the proximal right coronary artery and the left main coronary artery was assessed. Correlation of BSA with vessel attenuation was assessed in both groups. Interestingly, the authors found that BSA-matching was successful in all patients (BSA-adapted group 1.98 ± 0.15 m^2 versus the reference group 1.98 ± 0.17 m^2). Mean contrast material bolus was significantly smaller in the BSA-adapted versus the reference group (mean 70 ml vs. mean 80 ml). There was no correlation in the BSA-adapted group, while coronary attenuation was significantly inversely related to BSA in the reference group. It was concluded that a BSA-adapted contrast material protocol successfully results in a comparable coronary contrast enhancement independent of individual BSA. This was achieved despite a significant reduction in the overall contrast material amount. The findings of the present study therefore clearly show that the BSA-adapted contrast material administration protocol is feasible and successful as the inverse correlation between BSA and coronary attenuation found in the control group could be abolished. As a result, range and standard deviation of coronary attenuation were smaller in the BSA-adapted group compared to the control group, indicating a well-balanced consistent contrast enhancement throughout a large range of BSA. Furthermore, by using the BSA-adapted protocol a significantly lower average amount of contrast medium was injected, which may help preventing contrast induced nephropathy and its consequences.

Previous studies [55–58] from the same group directed by Kaufmann had already shown that the use of the proposed body mass index-adapted scanning parameters results in similar image noise regardless of body mass index. Tatsugami et al. [55] initially showed that an increased bolus dilution due to larger blood volume may account for the decrease in contrast-to-noise ratio and vessel attenuation in patients with higher body mass index, but in this study the contrast bolus was not adapted to body mass index. Herzog et al. [56] showed that, after successfully overcoming the impact of body mass index on image noise by adapting tube parameters, the contrast to noise ratio mainly depends on coronary vessel contrast. The latter reflects the dilution of the contrast material by blood volume and cardiac output, which are both correlated to BSA. Therefore, BSA-adapted contrast administration may help to compensate for this effect. Husman et al. [57, 58] recently reported that a BMI-adapted contrast material protocol results in adequate coronary vessel attenuation independent of individual body mass index despite a significant reduction in overall amount of contrast material used.

To summarize, the current study validly extends previous findings that the proposed BSA-adapted contrast material protocol in patients undergoing low-dose CTCA results in adequate coronary vessel attenuation independent of individual BSA.

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