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ECG-gated CT angiography of the thoracic aorta: the importance of evaluating the coronary arteries

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AIM: To evaluate the feasibility of coronary artery disease (CAD) evaluation using electrocardiogram-gated computed tomography CT of the thoracic aorta.

MATERIALS AND METHODS: A total of 477 patients, who underwent CT angiography of the thoracic aorta, were included retrospectively. Dose–length products (DLP) were recorded. Two blinded readers graded image quality of the coronary arteries on a three-point scale. Coronary artery stenosis has only been reported if considered significant, i.e., ≥50%. The type of plaque responsible for the stenosis was considered. The normal distribution of the data was assessed using Shapiro–Wilk and Anderson–Darling tests. Results were expressed as means and standard deviations and percentages. Inter-reader agreements were analysed by calculating the intraclass correlation coefficient, and by using Cohen kappa statistics.

RESULTS: The mean DLP was 566±90.4 mGy·cm, corresponding to an effective dose of 9.6±1.5 mSv. Five point three percent of asymptomatic patients were positive for CAD with stenosis ≥50%. All patients with coronary stenosis presented with a soft plaque. Two anomalous coronary origins were found. The inter-reader agreement was excellent in defining both the quality of the examination and the degree of coronary stenosis (k=0.85).

CONCLUSION: The opportunity to prove the presence of CAD in asymptomatic patients during a ECG-gated CT of the thoracic aorta can have an extremely important clinical impact, promoting the best therapeutic pathway for the patient. Therefore, coronary arteries should always be analysed carefully and reported in ECG-gated CT angiography of the thoracic aorta.

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Introduction

Computed tomographic (CT) angiography is an accurate tool for the evaluation of acute and chronic abnormalities of the thoracic aorta (e.g., dissection or aneurysm).[1] Because of the close proximity to the heart, the aortic root and ascending aorta move together with the left ventricle causing motion artefacts at thoracic CT angiography acquired without the use of electrocardiographic (ECG) assistance.[2] Motion artefacts can affect the quality of measurements and simulate aortic dissection or luminal irregularities leading to an erroneous diagnosis.[1]

ECG gating is now considered the preferred technique for thoracic CT angiography to reduce motion artefacts, particularly for the aortic root and ascending aorta.[2] Until recently, all of the studies were performed with retrospective ECG-gated imaging. Compared with non-gated techniques, this technique has a patient radiation dose that is relatively higher than newly introduced prospectively ECG-gated protocols, but which are more susceptible to deterioration of image quality due to artefacts from arrhythmia and heart rate variability.[3,4] Nowadays, several valid strategies are available and adopted for dose reduction in cardiothoracic radiology without compromising image quality.[5–9]

ECG-gated CT is preferable in the study of aortic pathology involving the aortic root and valve, in congenital heart disease, for simultaneous aorto-coronary evaluation, for planning of endovascular therapy, for imaging of the pre- and post-surgical ascending aorta, and to detect dynamic changes of true luminal compression in aortic dissection.[10]

Coronary CT angiography has been proven to be a safe method to diagnose coronary artery disease (CAD).[11–13] The possibility to identify CAD in asymptomatic patients who undergo a CT examination for the evaluation of the thoracic aorta would be of great clinical value. Indeed, patients with subclinical atherosclerosis identified by coronary CT angiography can be expected to benefit from preventive treatment because they are at elevated risk for a cardiac event.[14,15]

The purpose of the present study was to evaluate the feasibility of CAD evaluation from ECG-gated CT of the thoracic aorta.

Materials and methods

A total of 477 patients who underwent CT angiography of the thoracic aorta between March 2012 and December 2017 were included retrospectively. Informed consent was not requested. All patients were identified through the RIS/PACS (radiology information system/picture archiving and communication system).

In all patients ECG-gated CT angiography was performed for acute and chronic aortic diseases. Inclusion criteria were (1) acute and chronic aortic pathology involving the aortic root and valve, (2) congenital heart disease, (3) planning of endovascular therapy, (4) imaging of the pre- and post-surgical ascending aorta, (5) a heart rate <80 bpm, and (6) regular heart rate.

CT angiography protocol

Patients were scanned using a 64-section CT system (Brilliance and iCT, respectively, Philips, Philips Medical Systems, Best, The Netherlands). No B-blockers were given. A 18-G intravenous catheter was placed in the antecubital vein of the right arm, and 80 ml contrast medium (iomeprol, Iomeron 400, Bracco, Milan) was infused at 4.5 ml/s after an initial injection delay, depending on an attenuation of 120 HU in the descending aorta.

Imaging parameters were 64×0.625 mm section collimation with z-flying focal spot for the simultaneous acquisition of 128 overlapping 0.6 mm sections; 0.33 seconds gantry rotation, and a standard tube voltage of 100 kV with 600 mAs. For obese patients with a body mass index (BMI) of ≥30 kg/m^2, the tube voltage was increased to 120–140 kV and 800 mAs. The pitch value was 0.2 and the iDose4 Iterative reconstruction (IR) algorithm at level 4, was applied for the noise reduction.

ECG modulation of X-ray tube current was used with the aim to decrease the tube current during systole and early diastole and to maintain the full selected tube current in late diastole (Cardiac DoseRight, Philips). Cardiac DoseRight is a tool used during spiral CT to reduce the amount of radiation to the patient while maintaining good image quality. This technique is called ECG dose modulation. When Cardiac DoseRight is active, the scanner will use the current programmed only in the previously selected phase as the optimal phase for visualisation of the aorta and coronary arteries. In the remaining phases of the cardiac cycle, such as the phases used for the functional analysis, the current is reduced to 20% of the programmed current value. With Cardiac DoseRight, the savings in terms of dose can be up to 40%. Retrospective reconstructions were obtained at 75% of the R-R interval (in late diastolic phase).

Coronary artery assessment

The coronary arteries were analysed with a dedicated independent diagnostic viewing and processing workstation (the Philips Extended Brilliance Workspace). For the aim of the analysis, the coronary arteries were not divided into segments, but considered in their totality: right coronary artery (RCA) and left main coronary artery (LM), left anterior descending artery (LAD), and left circumflex artery (LCX).

Two radiologists with more of 10 years of experience in cardiovascular imaging performed the evaluation of the coronary arteries with a three-point scale (0–2) in order to verify the quality of the images in terms of presence of heart motion and respiratory artefacts and massive coronary calcifications. A score of 2 indicated excellent diagnostic images (Fig 1); 1, indicated images of sufficient quality for optimal diagnosis; and 0, indicated non-diagnostic images due to massive calcifications or severe heart motion or respiratory artefacts. Massive calcifications were defined as

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