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Abstract

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Reference


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Research paper

ECG-triggered high-pitch CT for simultaneous assessment of the aorta and coronary arteries

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ABSTRACT

Objectives: To study the image quality of ECG-gated-computed tomography (CT) acquisition with a high-pitch CT imaging for the exploration of both the aorta and coronary arteries.

Methods: Eighty-four patients underwent high-pitch ECG-gated aortic CT without β-blockers with iterative reconstruction algorithms. Contrast-to-noise ratio (CNR) between vessels and adjacent peri-vascular fat tissue were calculated on the aorta and the coronary arteries. Dose-length-products (DLP) were recorded. Two blinded readers graded image quality of the aorta and the coronary arteries on a 3-point scale. Coronary artery stenoses were compared with coronary angiograms in 24 patients. Kappa values were calculated.

Results: High-pitch acquisition resulted in a mean DLP of 234 ± 93 mGy cm (4.2 mSv) for an acquisition of the entire aorta, (mean 73 ± 16 bpm). CNR for ascending aorta was 10.6 ± 4 and CNR for coronary arteries was 9.85 ± 4.1. Image quality was excellent in 79/84 patients (94%), and excellent or moderate but diagnostic in 1087/1127 coronary artery segments (96%). 74 significant stenoses were observed, and 38/40 significant stenoses were confirmed by coronary angiography (K = 0.91, Sensitivity = 0.97, Specificity = 0.98).

Conclusion: High-pitch ECG-gated aortic CT with iterative reconstructions allows an accurate exploration of both aorta and coronary arteries during the same acquisition, with limited dose deposition, despite the lack of β-blockers and relatively high heart rate. Radiologists need to be aware of the necessity to analyze and report coronary artery disease in aortic examination.

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1. Introduction

The computed tomography angiography (CTA) of the aorta is a technical imaging challenge. One of the most important points is image quality, i.e. absence of artifacts, presence of vascular attenuation and contrast-to-noise ratio (CNR). These factors are crucial to reach a high accuracy for the diagnosis of the aortic disease, but the management of motion artifacts in the ascending aorta is of critical importance. Indeed, up to 57% of false intimal flap leading to misdiagnosis of dissection are caused by motion artifacts.9 This is mainly explained by an insufficient temporal resolution of conventional CT acquisitions.

Coronary-CT angiography has become a very useful technique for the depiction of coronary artery disease (CAD).2-4 Identification of asymptomatic patients who are at high risk of developing CAD is of major importance. Such patients may undergo CT for other indications, for instance aortic diseases, and subsequently extraction of accurate coronary analysis from the aortic CTA would be of great
clinical value. However, CT acquisition parameters are different for aortic imaging and for coronary imaging. So, aortic exploration may not be optimal for the analysis of coronary arteries, and additional acquisition may be required. As a consequence, if the exploration of both the aorta and coronary arteries is required, the resulting dose deposition is significant.

The recent development of new generation dual-source CT, high-pitch CT and new iterative reconstructions have led to image improvement by decreasing movement artifacts, decreasing image noise and increasing CNR of vessels. Published data addressing the ability of such protocols to allow accurate and combined explorations of both aortic and coronary arteries during the same acquisition are scarce, especially with low radiation deposition and regardless of the heart rate.

The purpose of this study was to evaluate the image quality and CNR of uniquely thoraco-abdominal ECG-gated acquisition with a high-pitch and iterative reconstructions algorithm for the exploration of both the aorta and coronary arteries.

2. Material and methods

2.1. Patient selection

This retrospective study was conducted in the radiology department of_. It was approved by the local institutional review board, and informed consents were waived.

The study was based on the CT data of 84 subsequent patients who underwent a contrast-enhanced CT of the complete aorta on the dual-source MDCT system from April to December 2013. CTA was performed for a suspicion of or a follow-up for aortic disease such as a dissection (n = 20, M/F: 16:4, mean age: 57 ± 20); thoracic aortic (n = 15, M/F: 7:8, mean age: 66 ± 14) or abdominal aneurysm.

\[
\text{CNR} = \frac{(\text{mean vessel attenuation} – \text{mean perivascular fat tissue attenuation})}{\text{standard deviation of perivascular fat tissue attenuation}}
\]

(n = 39, M/F: 35:4, mean age: 74 ± 10) or in order to plan a transcatheter aortic valve replacement (n = 10, M/F: 4:6, mean age: 82 ± 3). Patients previously underwent coronary angiography when indicated for their management.

The final study population consisted of 84 patients (62 males) with a mean age of 70 ± 16 years.

2.2. CTA acquisition protocol

All examinations were performed on a second-generation, dual-source MDCT system (Somatom Definition Flash, Siemens Healthcare, Forcheim, Germany). CT acquisition parameters were as follows: pitch: 3.2; rotation time: 0.28 s; collimation: 64 × 2 × 0.6 mm. An automated tube potential selection algorithm was used according to patient attenuation on the scout scan (CareKV) with a reference of 120 kV–250 mA, generating a kilovoltage of 80–140 and modulated mAs according to patient attenuation on the scout scan. All patients received an injection of 120 ml intravenous contrast medium (iohexol, 350 mg of iodine/ml; GE Healthcare) followed by 50 ml saline flush at a flow rate of 6 ml/s. The acquisition was initiated with a bolus tracking (region of interest (ROI) placed in the ascending aorta; threshold: 100 HU, scanning delay: 15 s). The thoracic, abdominal and pelvic CT acquisitions were performed in the cranio-caudal direction after synchronization to the ECG. Acquisition was designed to obtain diastolic images of the heart, i.e. by initiating the scanning so that the heart was scanned at 60% of the R-to-R-peak interval. No β-blockers or nitrates were administered for heart rate control or coronary vasodilation. Supplementary unenhanced or delayed acquisitions were performed according to the clinical situation, especially for patients with treated abdominal aortic aneurysm or suspected dissection. But, only arterial phase was used to assess the feasibility of a combined assessment of both the aorta and the coronary arteries.

A thoracic and abdominal images data set was reconstructed with iterative reconstruction algorithms (SAFIRE®-strength 3–kernel I26f) with a section thickness and an increment of 1.5/1 mm for the aortic analysis and 0.6/0.3 mm for the coronary artery analysis, respectively.

2.3. CT imaging analysis

2.3.1. Mean attenuation, image noise and contrast-to-noise ratio

ROI were manually drawn to measure the attenuation in Hounsfield units (HU) and were made as large as possible but avoiding calcium plaques and stenoses. ROIs were placed: 1) in the ascending thoracic aorta, and abdominal aorta just previously mentioned the iliac bifurcation; 2) at the origin of coronary arteries i.e. left main coronary artery (LM), left anterior descending artery (LAD), left circumflex artery (LCX), and right coronary artery (RCA); and 3) in the adjacent perivascular fat tissue. Image noise corresponded to the standard deviation of the attenuation of the ascending aorta as previously described.

CNR were also calculated at both the aortic levels and the origin of these four coronary arteries according to published data, as follows:

\[
\text{CNR} = \frac{(\text{mean vessel attenuation} – \text{mean perivascular fat tissue attenuation})}{\text{standard deviation of perivascular fat tissue attenuation}}
\]

(n = 3, non-diagnostic image quality with severe blurring of the vessel wall but diagnostic image quality; and 2, a moderate image quality with minor blurring of the vessel wall but diagnostic image quality: and 3, non-diagnostic image quality with severe blurring of the vessel wall or doubling of vessel contours. This analysis was performed at the level of the aortic valve, ascending aorta, descending aorta, with attenuations expressed in HU.

2.3.2. Image quality and artifacts

Coronary arteries were analyzed according to the 17 segments of the American Heart Association using an external workstation (Vitrea® Workstation, Vital Image, Minnetonka USA). The RCA includes segments 1–4, and segment 5 was defined as the LM. The LAD includes segments 6–8. Segments 9 and 10 correspond to the first and second diagonal branches and segments 11–15 to the LCX. Segment 16 was assigned to the posterior left ventricular branch originating from the RCA. The intermediate artery, if present, was defined as segment 17. Because of normal anatomical variations, not all coronary artery segments were present in all patients.

All CT were reviewed by two independent radiologists (_ and _) with 6 and 20 years experience in cardiovascular imaging. Readers were asked to grade the image quality and presence of respiratory motion and heart motion artifacts using a semi-quantitative 3-point scale, as follows: a score of 1 indicated excellent image quality without motion artifacts; 2, a moderate image quality with minor blurring of the vessel wall but diagnostic image quality; and 3, non-diagnostic image quality with severe blurring of the vessel wall or doubling of vessel contours. This analysis was performed at the level of the aortic valve, ascending aorta, descending aorta,
abdominal aorta and for each coronary segment. For each segment, the presence of stenosis was assessed and graded as follows: score 1, non-significant stenosis; score 2, significant stenosis (≥75%); and score 3, non-assessable stenosis (blooming artifacts due to calciumizations or a stent). A coronary artery lesion was defined as the presence of either a significant stenosis (score 2) or a non-assessable stenosis (score 3). When a significant stenosis was identified, the type of plaque was graded as: 1, non-calcified plaques (soft or fibrotic); 2, mixed plaques; 3, calcified plaques.

Finally, base on the heart rate (<65 bpm and >65 bpm), two sub groups were analyzed.

2.3.3. Estimation of radiation dose

The effective radiation dose was estimated from the mean of the CT Dose Index volume (CTDIvol) and with a method proposed by the European Working Group for Guidelines on Quality Criteria for CT13 using the dose–length product and a conversion coefficient (k). Conversion coefficients (mSv/(mGy cm)) vary from 0.015 for the abdomen to 0.014 for the chest, and 0.019 for the pelvis. We used the mean of these different region-specific conversion coefficients (k = 0.017 mSv/(mGy cm)), as previously described.1

2.4. Coronary angiography analysis

The coronary angiography images were retrospectively reviewed by a cardiologist (A.-L.) with 10 years of experience in interventional cardiology, blinded to the CTA images. The operator was asked to assess the image quality using the above-mentioned scale. He was then asked to perform the same analysis of the 17 segments of the coronary arteries using the above-mentioned scale.

2.5. Statistical analysis

Normal distribution of the data was assessed through a Kolmogorov-Smirnov test. Values were expressed as means (standard deviations), or medians (ranges) according to the distribution of the variable, and percentages, as appropriate. Inter-reader agreements were analyzed by calculating the intraclass correlation coefficient (ICC), and by using Cohen kappa statistics. All analyses were performed using the Statistical Package for the Social Sciences (SPSS) software (version 20.0, SPSS Inc., Chicago,IL,USA).

3. Results

3.1. Patients

Eighty-four adult patients (62 males, mean age 70 ± 16 years (range 19–94)) were included. No patient was excluded due to poor image quality. Patients had a mean body mass index of 26 ± 5 kg/m² (16–44). The mean heart rate was 71 ± 14 beats/min (49–113). The patients’ characteristics are summarized in the Table 1. The mean scan length was 615 ± 34 mm (540–690). The mean duration of data acquisition was 1.4 ± 0.1 s (1.1–1.6).

A total of 24 patients (29%) subsequently underwent planned coronary angiography according to the clinical management strategy (identification of CAD on the CT scan, planned TAVR, or preoperative assessment).

3.2. CT acquisition

3.2.1. Mean attenuation, image noise and contrast-to-noise ratio

The mean attenuation was 526 ± 154 HU (301–977) in the ascending aorta, 531 ± 153 HU (282–973) in the abdominal aorta. The mean image noise was 31 ± 6 HU (16–46). The mean CNR of the ascending aorta, and abdominal aorta was 20.3 ± 4.6 (11.4–33.7) and 20.6 ± 4.8 (11.8–34.9), respectively. The mean attenuation and the mean CNR of the coronary arteries are reported in Table 2.

3.2.2. Image quality and artifacts

Global aortic image quality was graded excellent in 80/84 patients (94%), and moderate in the remaining 4 patients (6%). No CT was considered of non-diagnostic quality (score 3). Respiratory motion artifacts were observed in only one patient and were considered as moderate. In 63/84 patients (75%), the acquisition was heart-beat-artifact free. Mild heart motion artifacts were present in 21/84 patients (25%). Non-diagnostic heart motion artifacts were never observed. Inter-observer agreement for global image quality and presence of artifacts are detailed in Table 3.

A total of 1082 CT coronary artery segments were evaluated. The inter-observer agreement for image quality grading was substantial (κ = 0.75). For reader 1, image quality was rated as excellent for 75% (810/1082) of the segments, moderate for 19% (206/1082), and non-diagnostic for 6% (66/1082). For reader 2, image quality was rated as excellent for 68% (724/1057) of the segments, moderate for 23% (242/1057), and non-diagnostic for 9% (91/1057). Overall, coronary arteries were visualized with diagnostic image quality (scores 1–2) in 1016 and 966 segments (94% and 91%) and in 51 and 43 patients (60% and 51%) for reader 1 and 2, respectively. 426/436 (98%) and 408/424 (96%) coronary segments were diagnostic (scores 1–2) with a heart rate <65 bpm versus 590/646 (91%) and 558/633 (88%) segments with a heart rate >65 bpm for reader 1 and 2, respectively (p < 0.001 and p < 0.001). This corresponded to 27/33 (82%) and 22/33 (67%) patients versus 24/51 (47%) and 21/51 (41%) patients for reader 1 and 2, respectively (p = 0.006 and p = 0.027).

When considering all patients with at least one non-diagnostic coronary segment, 45% and 37% of patients had only one non-diagnostic segment; and 33% and 29% had two non-diagnostic segments for reader 1 and 2, respectively.

Non-diagnostic image quality was most frequently found in the second segment of the RCA, 11/50 (22%) and 14/50 (28%) with heart
The inter-reader agreement was excellent for the RCA and LM (k = 0.83 ± 0.07, and k = 1.0 ± 0.0, respectively), and substantial for the LAD and LCX (k = 0.68 ± 0.05, and k = 0.76 ± 0.06, respectively). Overall the ICC was 0.76. The details for each segment are reported in Table 4.

Coronary angiography revealed 39 significant stenoses. Four stenoses suspected on the CT images were not confirmed on the coronary angiography. They corresponded to non-assessable lesions due to blooming artifacts. Conversely, four stenoses identified on the coronary angiography were missed on CTA images due to motion artifacts, notably on the second segment of the RCA. Overall, the agreement between CTA and coronary angiography was excellent (k = 0.91 ± 0.06). Overall, sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV), and accuracy of CTA for the identification of stenosis were 90%, 98%, 88%, 99%, and 98%, respectively. Details of the agreement for each segment are given in Table 5.

3.2.3. Estimated dose deposition

The mean CTDIv was 3.4 ± 1.3 mGy and the mean DLP was 232 ± 88 mGy cm for the complete aorta acquisition, corresponding to an effective dose of 3.9 ± 1.5 mSv.

4. Discussion

The present study aimed at evaluating the image quality of CT angiography for the simultaneous analysis of the complete aorta and coronary arteries in patients suspected of having aortic disease. Results showed that the use of dual-source CT with high-pitch and iterative reconstruction resulted in high image quality with limited artifacts and low dose deposition, and allowed combined analysis of the aorta and coronary arteries.

The possibility of a global analysis of both coronary and aortic abnormalities is a real challenge resulting from the combination of two different protocols. Dual-source CT scanners are characterized by two X-Ray tubes and two detectors offset by approximately 90°. They offer an increased temporal resolution, almost twice that offered by single source CT scanners.

Several studies have demonstrated the added value of high-pitch on the image quality of ascending aorta CTA without ECG

Table 3

<table>
<thead>
<tr>
<th>Image quality</th>
<th>Global quality</th>
<th>Breathing motion</th>
<th>Heart motion</th>
<th>Aortic Valve</th>
<th>Ascending aorta</th>
<th>Descending aorta</th>
<th>Abdominal aorta</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excellent qualitya</td>
<td>80</td>
<td>83</td>
<td>63</td>
<td>83</td>
<td>76</td>
<td>84</td>
<td>84</td>
</tr>
<tr>
<td>Moderate qualitya</td>
<td>4</td>
<td>1</td>
<td>21</td>
<td>1</td>
<td>8</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Non diagnosticb</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Kappa</td>
<td>1.00 ± 0.0</td>
<td>1.00 ± 0.0</td>
<td>0.93 ± 0.04</td>
<td>1.00 ± 0.0</td>
<td>0.92 ± 0.02</td>
<td>1.00 ± 0.0</td>
<td>1.0 ± 0.0</td>
</tr>
</tbody>
</table>

a Values are indicated as numbers of segments evaluated in 84 patients (n/84).

rate >65 bpm, but only 2/33 (6%) and 2/33 (6%) with heart rate ≤65 bpm (p = 0.06 and p = 0.02) for reader 1 and 2, respectively.

The possibility of a global analysis of both coronary and aortic abnormalities is a real challenge resulting from the combination of two different protocols. Dual-source CT scanners are characterized by two X-Ray tubes and two detectors offset by approximately 90°. They offer an increased temporal resolution, almost twice that offered by single source CT scanners.

Several studies have demonstrated the added value of high-pitch on the image quality of ascending aorta CTA without ECG

Table 4

<table>
<thead>
<tr>
<th>RCA</th>
<th>LM</th>
<th>LAD</th>
<th>LCx</th>
<th>Inter.</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nb of segments evaluateda</td>
<td>84</td>
<td>83</td>
<td>76</td>
<td>60</td>
<td>46</td>
</tr>
<tr>
<td>Kappa value</td>
<td>1.00 ± 0.0</td>
<td>1.00 ± 0.0</td>
<td>0.86 ± 0.05</td>
<td>1.00 ± 0.0</td>
<td>1.00 ± 0.0</td>
</tr>
<tr>
<td>Nb of segments evaluated</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Quality</td>
<td>Excellent</td>
<td>(score 1)</td>
<td>0.89 ± 0.05</td>
<td>0.96 ± 0.05</td>
<td>0.97 ± 0.06</td>
</tr>
<tr>
<td>Moderate</td>
<td>(score 2)</td>
<td>0.90 ± 0.06</td>
<td>0.99 ± 0.08</td>
<td>0.70 ± 0.08</td>
<td>0.78 ± 0.09</td>
</tr>
<tr>
<td>Non diagnostic</td>
<td>(score 3)</td>
<td>0.96 ± 0.06</td>
<td>0.97 ± 0.07</td>
<td>0.90 ± 0.08</td>
<td>0.92 ± 0.08</td>
</tr>
<tr>
<td>Intraclass Correlation Coefficient</td>
<td>0.83 ± 0.16</td>
<td>0.89 ± 0.16</td>
<td>0.88 ± 0.16</td>
<td>0.80 ± 0.16</td>
<td>0.72 ± 0.16</td>
</tr>
<tr>
<td>Nb of Coronary lesions evaluated</td>
<td>8</td>
<td>11</td>
<td>4</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Kappa value</td>
<td>1.00 ± 0.0</td>
<td>1.00 ± 0.0</td>
<td>0.74 ± 0.0</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td>Nb of segments evaluated</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Mixed plaque</td>
<td>3</td>
<td>4</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Calculated plaque</td>
<td>3</td>
<td>4</td>
<td>2</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>

LAD: left anterior descending artery; LCx: left circumflex artery; LM: left main artery; RCA: right coronary artery.

a Values are indicated as numbers of segments evaluated in 84 patients (n/84).
triggers, resulting in a sensitivity and a specificity of 100% for the diagnosis of aortic dissection. More recently, Bolen et al. have shown that high-pitch CTA with ECG-triggering provides higher image quality of the aortic root and ascending aorta when compared with a non-ECG-synchronized standard-pitch CT. Dual-source CT with high-pitch and no ECG triggering provided accurate motion-artifact-free imaging of the ascending aorta, but not of the coronary arteries. Therefore a high-pitch protocol is insufficient if coronary artery analysis is required.

Because an ECG-triggered high-pitch protocol leads to significantly fewer coronary motion artifacts, ECG triggering is mandatory if coronary arteries are to be explored with the same acquisition. The second generation of dual-source CT scan permits ECG-gated protocols with high-pitch up to 3.4. Such ECG-gated high-pitch protocols have been used to increase the speed of the acquisition, thus reducing heart motion artifacts, permitting the screening of CAD with a reduced radiation dose deposition. Present-day machines offer a high temporal resolution allowing the acquisition of the complete aorta together with coronary artery imaging. Indeed, at such high-pitch, 9.6–11.6 cm in the z-axis, acquisition can be performed in 250–300 ms, corresponding to a scan of the entire heart volume during a fraction of a single heartbeat. As a consequence, step-motion artifacts are virtually nonexistent.

ECG-gated aortic CT has already been used for the combined assessment of the aorta and the coronary arteries. Nevertheless, authors reported limitations especially for the analysis of the coronary arteries. Scharf et al., recommended the administration of β-blockers, while Goetti et al. and Fujioka et al. showed that acceptable image quality and diagnostic performance required a low heart rate (respectively less than 63 and 75 bpm), which may be related to a standardized CTA protocol with a tube voltage of 100 kV, a relative low-pitch protocol or the absence of iterative reconstructions.

The results of the present study show that such limitations can be overcome with an ECG-gated high-pitch protocol using iterative reconstructions. Indeed, image quality of the ascending aorta was found to be excellent, allowing reliable diagnosis. In addition, the vast majority of coronary artery segments (94%) were of diagnostic value in spite of a high heart rate and the absence of β-blocker administration, corresponding to 60% of the patients. Furthermore, significantly more coronary segments were diagnostic with a low heart rate (<65 bpm), but image quality remained diagnostic in 91% and 88% of the segments in patients with a high heart rate for reader 1 and 2, respectively. Moreover, in most the patients only one or two segments were non-diagnostic (78% and 66% for reader 1 and 2, respectively). We believe that it is a satisfying compromise for both analysis of the aorta and coronary arteries. As stated previously mentioned, in patients with non-diagnostic images, a dedicated segmented coronary acquisition should be considered.

The absence of medication administration is clinically relevant, because β-blocker administration is sometimes contraindicated in the emergency context, for patients with acute cardiovascular disease and at risk of developing hemodynamic instability. Furthermore the workflow is not affected by ECG positioning or drug administration. Because relevant clinical information can be obtained for the ascending aorta and coronary arteries, we recommend this protocol for aortic disease.

The use of a systolic window for high heart rate has been proposed by Sun et al. and Goetti et al. to improve the image quality of coronary arteries. Systolic imaging was not used in patients with fast heart rate as it induces a significant change in aortic diameter by comparison to diastolic imaging and as our referring physician were used to diastolic imaging. However, the benefit of systolic acquisitions for combined aortic and coronary CTA remains clearly to be investigated in further studies.

Indeed, another important advantage of the present CT protocol is the use of iterative reconstruction. Iterative reconstruction algorithms are now widely used routinely for vascular imaging and aim at reducing image noise while increasing CNR. The use of iterative reconstructions has already been studied with coronary CTA. It offers high image quality and can provide high diagnostic accuracy for the detection of coronary artery stenosis. In addition, iterative reconstruction algorithms are a post-processing option available for reducing radiation dose at CT. Several studies have shown that iterative reconstructions allowed a 50% reduction in dose deposition, while preserving image quality and diagnostic accuracy of coronary CTA. Schuhbaeck et al. demonstrated that for a coronary-CT, the addition of high-pitch with raw data-based iterative reconstruction results in a furthermore decrease in dose, while providing sufficient image quality with an estimated effective dose <0.1 mSv. In the present study, the acquisition protocol was optimized for CTA of the thoraco-abdominal aorta and not exclusively for the heart. Yet the effective dose was a mean of 3.9 ± 1.5 mSv. This is interesting, especially when compared with currently reported mean radiation dose for the assessment of the aorta and the coronary arteries in a single acquisition (ranging from 7.5 to 18.42 mSv).

CAD screening is essential in these patients suffering from aortic pathology involving the aorta, where the non-diagnostic imaging may be responsible for a significant morbidity and mortality. The study also highlights the importance of the development of automated software to perform CAD assessment.
disease and who are at high risk of developing CAD. Importantly, sensitivity and negative predictive value of coronary abnormalities are excellent, allowing exclusion of CAD on a normal CTA and also avoiding diagnostic coronary angiography. If CAD was diagnosed on the CTA, characterization of the coronary plaque was possible, as previously reported.30 Moreover, regarding recent publications, coronary calcifications would not be a contraindication to perform a coronary CT whatever the calcium scoring.31 (see Fig. 2)

Furthermore, aortic CTA was useful for planning a coronary angiography before a procedure such as TAVR, coronary treatment or coronary artery by-pass graft analysis. In our study, after the identification of previously unknown CAD, the management of the aortic disease of two asymptomatic patients was completely changed. Finally, there are 2 clinical implications of our study: first, coronary arteries should always be carefully analyzed and reported in gated aortic high-pitch CTA as a very high number of coronary segments are of diagnostic quality even at heart rate >65 bpm. Coronary artery analysis is no longer restricted to specialized

Fig. 1. Aortic-CTA of 70 year-old male and 65 year-old female with aortic dissection with 63 beats per minute (Fig. 1a/1b/1c/1d) and with 86 beats per minute (Fig. 1e/1f/1g/1h) on different Volume Rendering techniques and curve MultiPlanar reconstructions of the aorta (1a/b/e/f) and of coronary arteries (1c/d/g/h). For these 2 patients, the analysis of the whole aorta and coronary arteries could be possible: aortic dissection was clearly seen and coronary artery disease was depicted or excluded (arrows) despite the relatively high heart rate.

Fig. 2. 68-year-old man with RCA stenosis due to a mixed plaque on different curve MPR reconstructions (a/b). Coronary angiography confirmed the significant stenosis (c) with an excellent result of the angioplasty (d).
cardiac radiologist but really needs to be mastered by every radiologist. Then, when a combined examination of aorta and coronary arteries is required, a high pitch CTA protocol with ECG gating of the entire aorta could be performed first. In case of motion artifacts, and when clinically required, a dedicated segmented acquisition targeted to heart could be performed.

Aside from its retrospective design, this study has several limitations. First, the smaller detector of the dual-source system covers a field of view of 60 cm². Thus a portion of subcutaneous abdominal structures may be cropped, especially in obese patients. Nevertheless, the analysis of central arteries has never been compromised, including the iliac and femoral arteries. Secondly, the diagnostic performance of coronary CAT was verified in only 24 patients with invasive coronary angiography. Coronary CTA has become a robust clinical tool for the diagnosis and exclusion of CAD. Due to its high sensitivity and negative predictive value, only patients with suspected CAD underwent coronary angiography. Thirdly, because half the patients included underwent CTA for abdominal aeurism or before TAVR, this is responsible for a predominantly elderly and male population, well correlated with the literature but no different diagnostic accuracy of the coronary-CT angiography of the thoracic and abdominal aorta: is simultaneous coronary artery assessment possible? AJR Am J Roentgenol. 2010;194:938–944.


