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CARDIOVASCULAR IMAGING

ORIGINAL ARTICLE

Role of DECT in coronary artery disease: a comparative study with ICA and SPECT

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PURPOSE

Earlier imaging techniques for coronary artery disease (CAD) focused primarily on either morphological or functional assessment of CAD. However, dual-energy computed tomography (DECT) can be used to assess myocardial blood supply both morphologically and functionally. We aimed to evaluate the diagnostic accuracy of DECT in detecting morphological and functional components of CAD, using invasive coronary angiography (ICA) and single photon emission computed tomography (SPECT) as reference standards.

METHODS

Twenty-five patients with known or suspicious CAD and scheduled for ICA were investigated by DECT and SPECT. DECT was performed during the resting state using retrospective electrocardiography (ECG) gating. CT coronary angiography and perfusion images were generated from the same raw data. All patients were evaluated for significant stenosis (≥50%) on both ICA and DECT coronary angiography, and for myocardial perfusion defects on SPECT and DECT perfusion. Comparison was done between ICA and DECT coronary angiography for detection of significant stenosis and between SPECT and DECT perfusion for detecting myocardial perfusion defects.

RESULTS

Using ICA as reference standard, sensitivity, specificity, and accuracy of DECT coronary angiography in detecting ≥50% stenosis of coronary artery lumen were 81.6%, 97.8%, and 95.0%, respectively, by segment-based analysis and 92.1%, 96.1%, and 93.7%, respectively, by vessel-based analysis. Using SPECT as the reference standard, the sensitivity, specificity, and accuracy of DECT perfusion in detecting myocardial perfusion defects were 70.4%, 86.4%, and 80.6%, respectively, on per-segment analysis and 90.7%, 66.6%, and 84.7%, respectively, on per-territorial basis.

CONCLUSION

DECT accurately detected coronary artery stenosis and myocardial ischemia using ICA and SPECT as reference standards. In the same scan, DECT can accurately provide integrative imaging of coronary artery morphology and myocardial perfusion.

Coronary artery disease (CAD) refers to narrowing of coronary artery lumen, usually due to atherosclerosis. Pathological changes occur in the coronary artery wall with formation of atheromatous plaque leading to myocardial ischemia. CAD is the leading cause of mortality and morbidity in the developed countries (1). The main aim in patients with CAD is to detect coronary artery stenosis with a hemodynamically relevant effect on myocardial perfusion (2, 3). Thus, both anatomic and functional imaging are required to identify patients who will benefit from coronary intervention. Earlier imaging techniques were limited in their utility. Individual techniques either evaluated the morphology of coronary arteries or did functional assessment of the heart. However, dual-energy computed tomography (DECT) can be used to assess myocardial blood supply both morphologically and functionally (4, 5).

Single photon emission computed tomography (SPECT) myocardial perfusion is a well-established noninvasive imaging technique for evaluating known or suspicious CAD patients. Sensitivity and specificity of SPECT for the detection of CAD in comparison with ICA are 82%–98% and 44%–91%, respectively (6, 7). It is, however, unable to evalu-

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ate stenosis of the coronary artery that is responsible for causing perfusion defects. This identification is essential for therapy planning (8, 9). As a result, invasive coronary angiography (ICA) is often done in patients with abnormal SPECT findings to plan accurate therapy (10). Since, generally relative perfusion is assessed with SPECT, it has reduced sensitivity for detecting balanced ischemia due to left main CAD or triple vessel disease (11).

CT coronary angiography is a widely performed noninvasive technique to assess CAD. Because of its high sensitivity and negative predictive value, it can be used to effectively exclude significant CAD and to avoid further imaging in patients who are at low-to-intermediate risk for CAD (12–16). Standard CT coronary angiography is limited by lack of information on the hemodynamic significance of coronary stenosis (4, 17, 18). Techniques such as CT myocardial perfusion and CT-derived fractional flow reserve (FFR) have recently been introduced for functional CT assessment of CAD effects on myocardial blood flow (19, 20).

CT-derived FFR is a recently introduced noninvasive image postprocessing technique that complements CT coronary angiography with physiologic information. No additional CT sequences or pharmacological stress agents were needed. The diagnostic accuracy of CT-derived FFR is comparable to that of invasive FFR (19). CT-derived FFR is limited in patients with previous myocardial infarction, stent implantation, coronary artery bypass grafts and extensively calcified atherosclerosis (20).

Main points

- The main aim in patients with CAD is to detect coronary artery stenosis with a hemodynamically relevant effect on myocardial perfusion.
- Low spatial resolution of SPECT limits diagnosis of subendocardial perfusion defects, which can be detected by DECT owing to its superior spatial resolution.
- DECT allows diagnosis of CAD by accurate detection of coronary artery stenosis and myocardial ischemia in a single scan.
- DECT can reduce radiation dose for patients who need to be evaluated with both ICA and SPECT for evaluation of coronary arteries and myocardial perfusion.

CT myocardial perfusion techniques are evolved to provide information on the hemodynamic significance of coronary stenosis. Currently there are two different strategies for CT-based myocardial perfusion. One strategy is the quantitative method, which involves dynamic time-resolved acquisition at multiple time points during the passage of contrast bolus through the myocardium. The second strategy is the qualitative method, which uses visual perception of density differences in myocardium to distinguish ischemic from normal myocardium. Myocardial blood content is visually evaluated during the early arterial phase of myocardial contrast enhancement. Ischemic or infarcted segments with reduced perfusion have a reduced delivery of contrast during the first-pass of contrast through the left ventricle, resulting in perfusion defect (21).

The introduction of dual-source CT scanners enabled acquisition of both luminography and perfusion data in a single scan. DECT involves image acquisition at more than one energy X-ray spectrum during one examination. The principle of DECT is material decomposition based on attenuation differences at different energy levels. Iodine as a contrast material has unique absorption characteristics when penetrated with X-ray spectra of different energy levels, which allows mapping the myocardial iodine distribution. DECT, especially when reconstructed as iodine maps, has an advantage over single-energy CT in qualitative myocardial perfusion imaging because perfusion defects are more conspicuous in DECT compared with single-energy CT (22).

In our study, we evaluated the value of DECT in diagnosing CAD by assessing both morphological and functional aspects with ICA and SPECT as reference standards, respectively.

Methods

Patient population

Twenty-five known or suspicious CAD patients scheduled for ICA were included in our study between January 2015 and December 2015. Patients with severe heart failure (NYHA III or IV), arrhythmias, renal failure, and allergic reactions to iodinated contrast were excluded from the study. One patient was excluded from the study because of significant motion during the scan. The age of patients varied from 35 to 85 years and the median age of patients was 59 years. There were 21 men and 3 women.

Study design

Study was prospective and known or suspicious CAD patients were evaluated first with ICA followed by DECT within 10 weeks of ICA (Mean time between ICA and DECT, 38±19.31 days). This was followed by SPECT within 2 weeks of DECT (Mean time between SPECT and DECT, 7.8±4.09 days). Results of ICA, SPECT, and DECT were interpreted by an experienced cardiologist (R.V.), nuclear medicine physician (A.S.), and cardiac radiologist (M.S.), respectively. Findings of each investigation were blinded to each other and analyzed by a fourth researcher (K.P.R.) (Fig. 1).

The study was approved by the institutional ethics committee and departmental publication review board (RDG/EC/P 104). Written informed consent was obtained from all patients.

DECT data acquisition

The patients were kept nil orally for at least 6 hours before the procedure. All patients were examined in dual-energy mode using second generation dual-source computed tomography (DSCT) 128-slice scanner (SOMATOM sensation-definition-flash, Siemens Healthcare) with temporal resolution 75 ms, gantry rotation time 0.28 s, slice/ beam thickness 0.6 mm. DECT angiography was performed during the rest state using a retrospective electrocardiography (ECG)-gated helical scan in the craniocaudal direction. Beta blockers were used for regulation of heart rate. Studies were done with dual-phase intravenous contrast injection of 80–90 mL of non-ionic iodinated medium at flow rate 5.5–6.0 mL/s, followed by a saline chaser with a dual head power injector via cubital vein. Bolus tracking technique was used, in which image acquisition was started 10 s after attenuation in the descending thoracic aorta reached the pre-set attenuation value of 100 HU during the first pass of contrast medium. Scan range was from carina to just below the level of diaphragm. Customized scanning parameters and ECG-gated tube current modulation were used to ensure minimum possible radiation exposure.

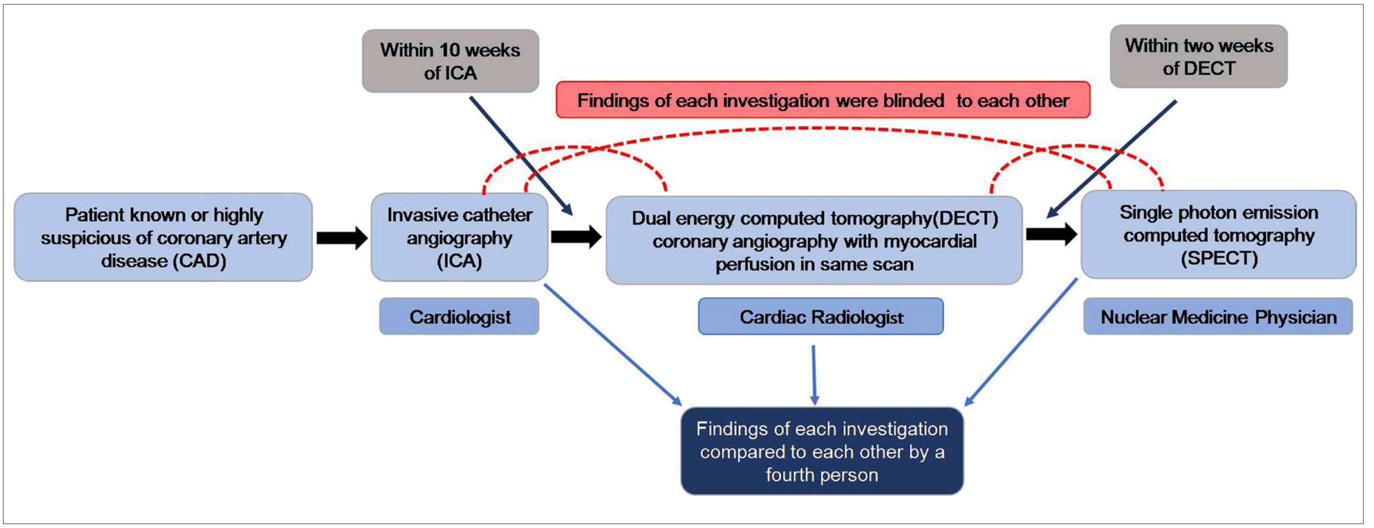

Figure 1. Diagram showing study design.

DECT postprocessing

Postprocessing was done on a dedicated syngo.via workstation (Siemens Healthcare) for reconstruction of coronary artery images. For DECT angiography images, 140 kV and 100 kV images were mixed with a weighing factor of 0.3 (70% of the 140 kV spectrum and 30% of 100 kV spectrum). BestPhase technique (Siemens Healthcare) was used to identify optimal reconstruction phases without user interaction. The optimal phase for reconstruction fell into 60%–80% of RR interval in patients with low heart rate (<70 bpm) or 40%–80% of RR interval in patients with high heart rate (>70 bpm). Reconstructed images were transferred to syngo.via workstation (Siemens Healthcare).

DECT perfusion images were generated from the same raw data for myocardial perfusion analysis. Using DE Heart PBV (Siemens Healthcare) software, iodine maps representing myocardial blood pool were generated to analyze myocardial perfusion. Myocardial wall with normal perfusion was chosen to normalize iodine maps for evaluating perfusion as suggested by Schwarz et al. (23).

ICA protocol

A standard femoral approach (Seldinger technique) was utilized. A 5 F pigtail catheter was placed in the root of the aorta and flush aortogram was obtained by injecting 50% diluted nonionic contrast. Selective cannulation of the left main trunk and the right coronary artery (RCA) was done using 5 F curved tip catheter and angiograms were obtained. All cases were done in either GE Health care or Siemens Healthcare systems.

SPECT/CT protocol

Patients were kept fasting for at least 4 hours before the study. Antianginal medications (calcium channel blockers/nitrates) were stopped 12–24 hours before the test. In case of adenosine stress testing, caffeine was avoided 12 hours prior to the test. In case of physical stress in the form of treadmill test, beta blockers were stopped 48 hours prior to the study. Tc99m-tetrofosmin (7 mCi) was injected at third minute of adenosine infusion and infusion was continued for another 3 minutes (at the rate of 140 μg/kg/min); in treadmill test, Tc99m-tetrofosmin (7 mCi) was injected at peak stress and exercise was continued for another 1–2 minutes. After 30-45 minutes of radiotracer injection, gated SPECT study was performed using a dual head gamma camera equipped with high resolution collimator. A 64×64 matrix, 32 projector, 25 s/projection and 24 frames/cycle were used in association with 20% window at 140 keV energy peak of Tc-99m tetrofosmin. Low dose CT (2.5 mA, 140 kVp) was used for attenuation correction. Rest study was done 3 hours after completion of stress study by reinjection of Tc-99m tetrofosmin (21 mCi) using similar acquisition parameters. The acquired images were then processed using AutoQUANT software from Cedars-Sinai group.

Data interpretation

To assess DECT coronary angiography and ICA data, coronary artery segmentation was done according to the American Heart Association (AHA) 15 segment model: RCA comprised of segments 1–4; left main coronary artery, segment 5; left anterior descending (LAD), segments 6–10; and left circumflex artery (LCX) segments 11–15. The intermedius artery, if present, was designated segment 16. Depending on the severity of luminal narrowing, a segment was classified as normal, nonsignificant stenosis (<50% narrowing) and significant stenosis (≥50% narrowing). The segments with caliber <1.5 mm and heavily calcified segments were excluded from the analysis. DECT angiography images were interpreted by an experienced radiologist who was blinded to ICA results, and ICA images were evaluated by an experienced cardiologist who was blinded to CT results. Both results were compared.

The DECT perfusion images were interpreted by a radiologist who was blinded to SPECT results. The DECT perfusion findings were compared with the SPECT findings confirmed by experienced nuclear physician. The myocardial perfusion in both DECT and SPECT was assessed based on the AHA 17 segment model. Myocardial perfusion defects were classified as reversible when seen only on stress SPECT and as fixed when seen both on the stress and rest SPECT.

Statistical analysis

SPECT myocardial perfusion imaging was used as reference standard. The data were analyzed to determine the diagnostic accuracy, sensitivity and specificity of DECT perfusion

Table 1. Per-segment and per-vessel analysis of DECT coronary angiography compared to ICA

DECT vs. ICA	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	Accuracy (%)
Per-segment	81.6	97.8	88.8	97.8	95.0
Per-vessel	92.1	96.1	97.2	89.2	93.7

DECT coronary angiography results are compared to ICA for detection of significant coronary artery stenosis.
DECT, dual-energy computed tomography; ICA, invasive coronary angiography, PPV, positive predictive value; NPV, negative predictive value.

Table 2. Vessel-based analysis of DECT coronary angiography compared to ICA

DECT vs. ICA	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	Accuracy (%)
RCA	94.4	100.0	100.0	85.7	95.6
LAD	92.3	88.8	92.3	88.8	90.9
LCX	85.7	100.0	100.0	94.4	94.7

Vessel-based DECT coronary angiography results are compared to ICA for detection of significant stenosis.
DECT, dual-energy computed tomography; ICA, invasive coronary angiography, PPV, positive predictive value; NPV, negative predictive value; RCA, right coronary artery; LAD, left anterior descending; LCX, left circumflex artery.

Table 3. Per-segment, per-territory and per-patient analysis of DECT perfusion compared to SPECT

DECT vs. SPECT	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	Accuracy (%)
Per-segment	70.4	86.4	75.0	83.5	80.6
Per-territory	90.7	66.6	89.0	70.5	84.7
Per-patient	100.0	50.0	95.6	100.0	95.8

DECT perfusion results are compared to SPECT for the detection of perfusion defects.
DECT, dual-energy computed tomography; SPECT, single photon emission computed tomography; PPV, positive predictive value; NPV, negative predictive value.

Table 4. Diagnostic accuracy of CT coronary angiography compared to ICA

Author of study	CT scanner	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)
Raff et al. (38)	64-row MDCT	86.0	95.0	66.0	98.0
Nikolaou et al. (39)	64-row MDCT	82.0	95.0	72.0	97.0
Mühlenbruch et al. (40)	64-row MDCT	86.7	95.2	75.2	97.7
Yi Xu et al. (41)	DSCT	97.4	97.8	92.2	100.0
Scheffel et al. (42)	DSCT	96.4	97.5	85.7	99.4

Results of previous studies comparing diagnostic accuracy between CT coronary angiography and ICA.
CT, computed tomography; ICA, invasive coronary angiography; PPV, positive predictive value; NPV, negative predictive value; MDCT, multidetector computed tomography; DSCT, dual source computed tomography.

for detecting perfusion defects on per-patient, per-segmental and per-territorial basis. Kappa test was used to assess agreement in the detection of perfusion defects between two imaging modalities. The strength of agreement based on Kappa values *(κ)* were as follows: 0–0.2 low, 0.21–0.4 moderate, 0.41–0.6 good, 0.61–0.8 substantial, 0.8–1 perfect agreement. All calculations were performed using SPSS (version 22.0; IBM Corp.).

Results

In 24 patients, 279 of 365 coronary artery segments (76%), including 5 ramus intermedius were evaluated. Out of 365 segments, 86 segments (32%) were excluded from the analysis either due to small caliber at their origin or heavy calcification. ICA detected significant stenoses among 49 of 279 segments (18%). DECT coronary angiography revealed significant stenoses in 44 of 279 segments (16%).

In 24 patients, 64 of 72 vessels (89%) were evaluated for significant stenosis. Out of 72 vessels, 8 (11%) heavily calcified vessels and small caliber vessels (at their origin) were excluded from the analysis. ICA and DECT coronary angiography detected significant stenoses in 38 of 72 (53%) and 36 of 72 (50%) vessels respectively. The performance characteristics of DECT angiography compared to ICA on per-segment and per-vessel analysis are listed in Table 1.

Out of 38 vessels with significant stenoses detected by ICA, 18 (47%) were in RCA, 13 (34%) were in LAD, and 7 (18%) were in LCX. Out of 36 vessels with significant stenoses detected by DECT angiography; 17 (47%) were in RCA, 13 (36%) were in LAD, and 6 (17%) were in LCX. The vessel-based performance characteristics of DECT angiography compared to ICA are listed in Table 2.

In comparison of DECT perfusion with SPECT, 408 myocardial segments and 72 territories were analyzed in 24 patients. SPECT revealed myocardial perfusion defects in 149 of 408 segments (37%) and 54 of 72 territories (75%). In 8 of 149 segments (5%), there were reversible perfusion defects (Fig. 2), and in others, perfusion defects were fixed (Figs. 3, 4). DECT perfusion revealed perfusion defects in 140 of 408 segments (94%) and 55 of 72 territories (79%). DECT revealed perfusion defects in 23 of 24 patients (96%). Rest SPECT revealed perfusion defects in 20 of 24 patients (83%) and stress SPECT revealed perfusion defects in 22 of 24 patients (92%). The performance characteristics of DECT perfusion compared to SPECT are listed in Table 3. The Kappa test showed good agreement in identifying myocardial perfusion defects between DECT perfusion and SPECT by per-segmental and per-territorial analysis ($\kappa = 0.56$; $P < 0.001$ for rest SPECT, $\kappa = 0.57$; $P < 0.001$ for stress SPECT using per-segmental analysis and $\kappa = 0.58$; $P < 0.001$ using per-territorial analysis).

In one patient (Fig. 5), SPECT did not reveal any perfusion defect; however, subendocardial perfusion defects, involving LCX territory, were seen on DECT. Further LCX stenosis was confirmed by ICA. Low spatial resolution of SPECT is known to limit diagnosis of subendocardial perfusion defects. This led to a false-positive result with decrease in specificity of DECT perfusion.

Discussion

Our study confirmed that DECT allows diagnosis of CAD by accurate detection of coronary artery stenosis and myocardi-

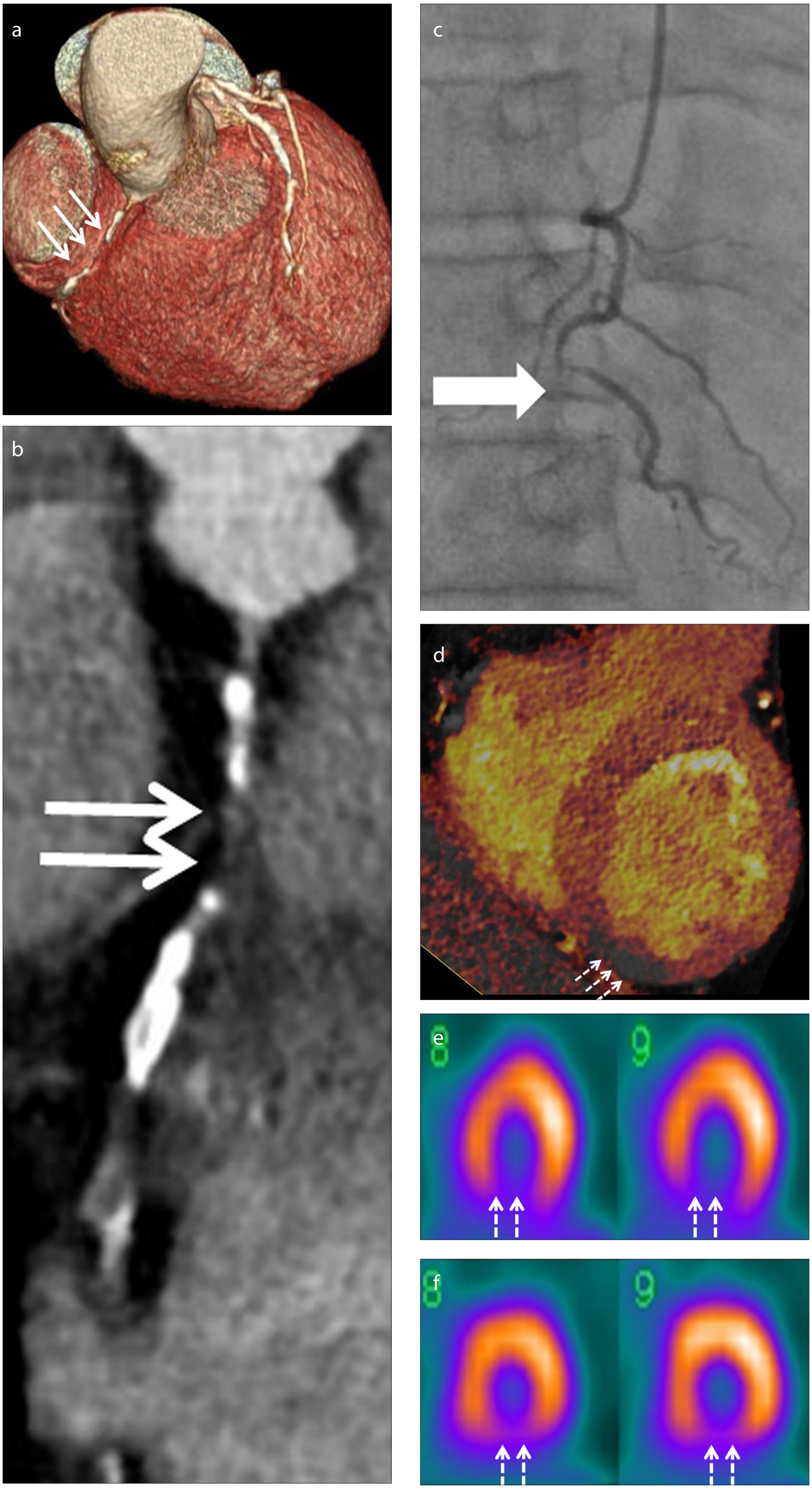

Figure 2. a–f. Reversible perfusion defect in RCA territory in a 52-year-old male CAD patient. Volume-rendered **(a)** and curved multiplanar reformatted **(b)** DECT coronary angiography images show area of non-opacification of RCA *(arrows)*. ICA **(c)** shows complete occlusion of RCA *(bold arrow)*. DECT perfusion short axis view **(d)** shows perfusion defect in inferior left ventricular myocardium in RCA territory *(dashed arrows)*. Short axis view of stress **(e)** and rest **(f)** SPECT reveals reversible ischemia *(dashed arrows)* in inferior and adjacent infero-septal segments (RCA territory).

al ischemia in single scan, using ICA and SPECT as reference standards.

The sensitivity and specificity of DECT coronary angiography to detect significant stenosis (using ICA as reference in our study) were determined as 81.6% and 97.8%, respectively. These findings are comparable to outcomes of previous studies conducted on 64-row detector scanner and somewhat lower compared to previous studies done on DSCT scanner (Table 4). This may be explained by the fact that temporal resolution in dual energy mode is identical to 64-row detector scanners. The temporal resolution of DSCT decreases from 83 ms to 165 ms for DECT acquisitions (24). Another possible explanation for low sensitivity in our study compared to previous studies done on DSCT scanners is that the protocol of DECT imaging in our study was such that the acquisition was started 10 s after the attenuation reached the pre-set attenuation value. The acquisition was done at peak myocardial enhancement rather than at peak arterial enhancement with focus on myocardial perfusion imaging rather than on coronary artery luminography. There are chances of relatively poor opacification of coronary arteries with more delay in acquisition.

Previous qualitative DECT myocardial perfusion studies reported 42%–94% sensitivity and 71%–98% specificity for DECT in detecting myocardial ischemia (24–32). In our study, DECT showed 70.4% sensitivity and 86.4% specificity, which were comparable to previous studies. DECT at rest accurately identified reversible myocardial ischemia, which was detected only on stress SPECT. Possible explanations include: (a), Superior spatial resolution of CT in comparison to SPECT which allows detection of those smaller subendocardial perfusion defects that are not detectable on rest SPECT; (b), vasodilatory effect of iodine which may cause hyperemia; (c), iodine contrast kinetics may have wider dynamic range at increasing coronary blood flow than SPECT, allowing detection of subtle decrease in myocardial perfusion (30). However, these explanations need appropriate studies for confirmation.

Dynamic CT myocardial perfusion studies have shown good diagnostic accuracy for detecting myocardial perfusion defects (5). Limitations include high radia-

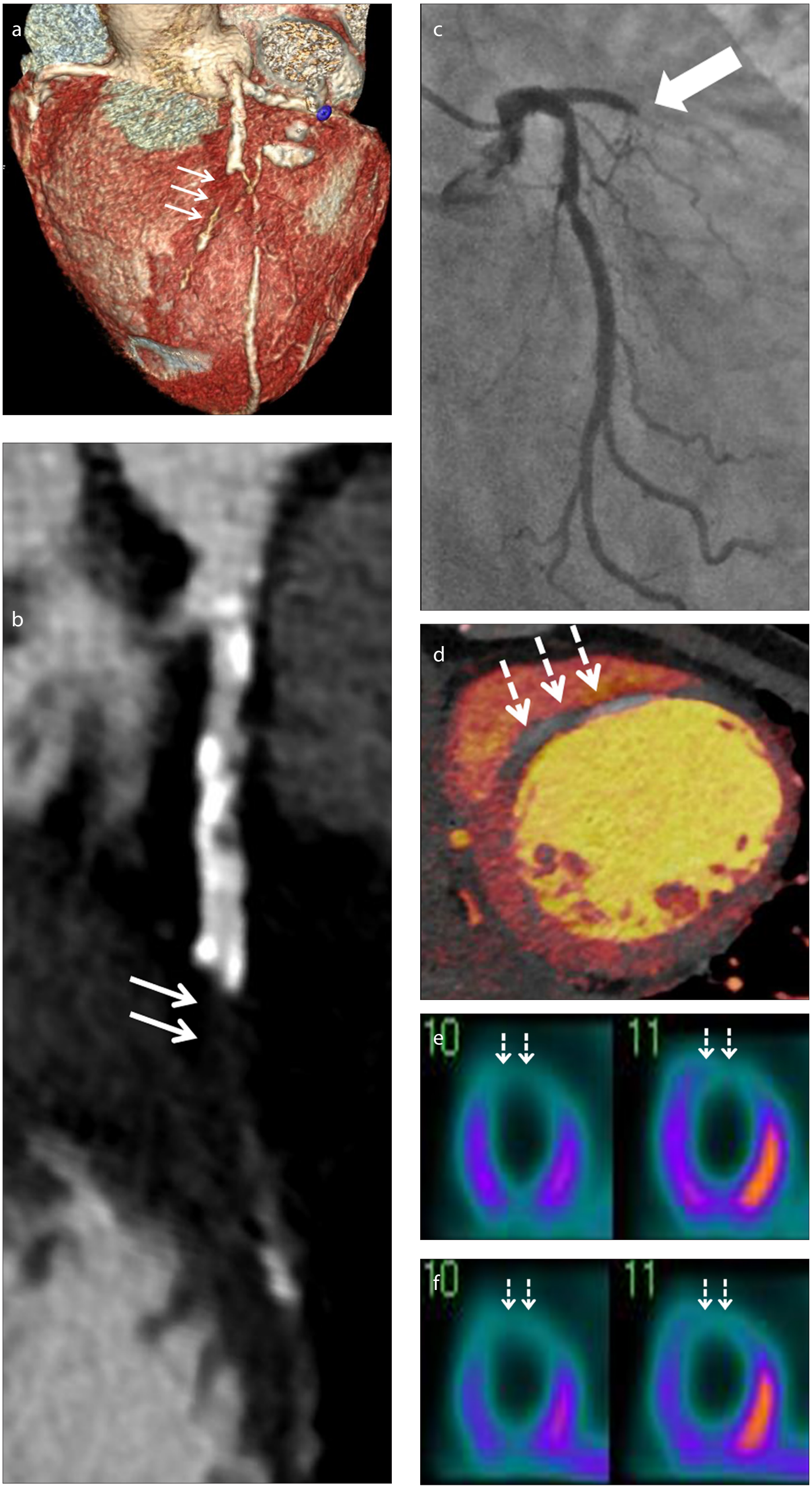

Figure 3. a–f. Fixed perfusion defect in LAD territory in a 68-year-old male CAD patient. Volume-rendered **(a)** and curved multiplanar reformatted **(b)** DECT coronary angiography images show non-opacification of LAD beyond the origin of first diagonal branch *(arrows)*. ICA **(c)** confirms occlusion of LAD *(bold arrow)*. DECT perfusion short-axis view **(d)** shows perfusion defects *(dashed arrows)* in anterior, adjacent parts of anteroseptal and anterolateral myocardium (LAD territory). Short-axis view of stress **(e)** and rest **(f)** SPECT show fixed defects *(dashed arrows)* in anterior, adjacent parts of anteroseptal and anterolateral segments (LAD territory).

tion exposure and relatively long breath-hold necessary for whole heart scanning. Furthermore, dynamic CT perfusion must be performed in addition to the CT coronary angiography for the assessment of coronary artery stenosis (33). Kurata et al. (34) showed good correlation between qualitative and quantitative CT myocardial perfusion techniques.

One of the advantages of DECT compared to SPECT and ICA was that structures in the field of view apart from coronary arteries and myocardium can also be evaluated. DECT allows detection of mural abnormalities whether it is coronary arteries or aorta, abnormalities of lungs, status of pulmonary arteries and cardiac chambers. In our study, a case with multiple lung nodules in centrilobular distribution suggesting pulmonary tuberculosis was detected besides true aneurysms of the left ventricular apex in three cases, which were not detected either by SPECT or ICA. Similar observations were reported by Knickelbine et al. (35), where nonatherosclerotic cardiovascular abnormalities such as left ventricular apical aneurysm, pulmonary embolus, ascending aortic aneurysm were seen in suspected CAD patients who underwent CT coronary angiography. Identification of nonatherosclerotic abnormalities have an impact on management strategy of the patient.

Radiation dose is a concern in patients undergoing CT examination. In our study, the median radiation exposure per patient for DECT was 5.18 mSv with an inter-quartile range of 2.10 mSv. The conversion factor used in our study was 0.017 mSv/mGy·cm. The average radiation exposure for rest/stress SPECT was 9.3–9.9 mSv and for ICA was 3–10 mSv (25). The mean effective radiation dose of DECT per patient was much lower than SPECT or both SPECT and ICA. So DECT can decrease radiation dose for patients who need to be evaluated with both ICA and SPECT for evaluation of coronary arteries and myocardial perfusion, respectively.

Our study is limited by a relatively small sample size. Further studies with larger sample size are needed to know the exact diagnostic accuracy of DECT. Second, we were not able to distinguish reversible from fixed perfusion defects on DECT perfusion, as stress imaging was not done. Thus, on DECT, we were not able to distinguish ischemia from infarction. The true value of DECT per-

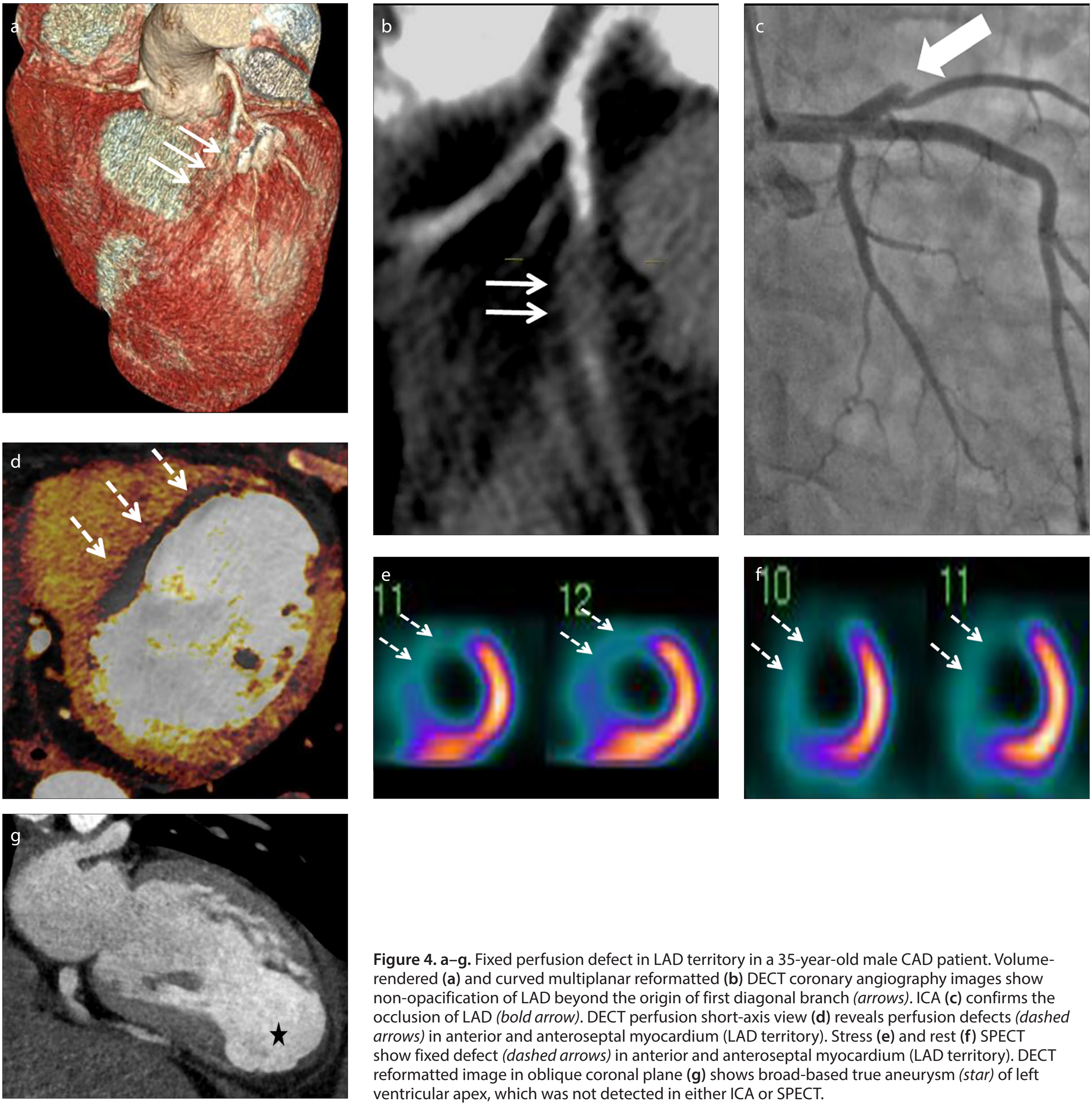

Figure 4. a–g. Fixed perfusion defect in LAD territory in a 35-year-old male CAD patient. Volume-rendered **(a)** and curved multiplanar reformatted **(b)** DECT coronary angiography images show non-opacification of LAD beyond the origin of first diagonal branch *(arrows)*. ICA **(c)** confirms the occlusion of LAD *(bold arrow)*. DECT perfusion short-axis view **(d)** reveals perfusion defects *(dashed arrows)* in anterior and anteroseptal myocardium (LAD territory). Stress **(e)** and rest **(f)** SPECT show fixed defect *(dashed arrows)* in anterior and anteroseptal myocardium (LAD territory). DECT reformatted image in oblique coronal plane **(g)** shows broad-based true aneurysm *(star)* of left ventricular apex, which was not detected in either ICA or SPECT.

fusion can be assessed only when the stress phase is added to the protocol. However, the addition of stress imaging to protocol increases the radiation dose and the amount of contrast medium. Third limitation was the unknown impact of beta blockers. Previous studies showed the effect of beta blockers on exercise or dobutamine myocardial perfusion imaging. These studies found that beta blockers alter myocardial blood flow and decrease the sensitivity of detecting CAD (36). However a recent study has suggested that beta blocker therapy does not affect the extent, reversibility and severity of perfusion defects on adenosine SPECT (37). In our study beta blockers were used before the DECT but were withdrawn 48 hours before SPECT examination. The influence of beta blockers on the results remains unclear. The effect of beta blockers on visual assessment of myocardial perfusion defects on DECT needs to be studied. Fourth, all patients in our study were known or suspected CAD patients with significant coronary artery stenosis, which may lead to overestimation of sensitivity of DECT perfusion. Fifth, DECT imaging is a newly introduced noninvasive imaging technique and there are no documented optimal diagnostic criteria for image acquisition and interpretation.

In conclusion, unlike SPECT, which is used as a stand-alone test for myocardial perfusion imaging, true value of DECT is

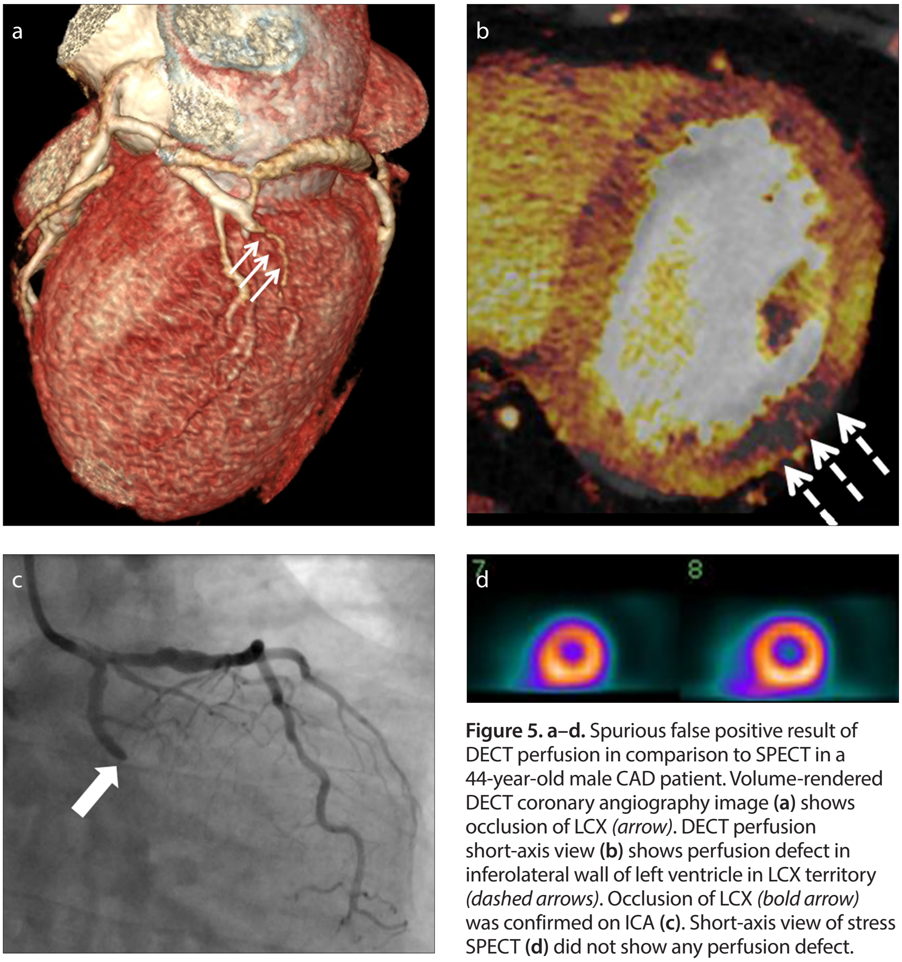

Figure 5. a–d. Spurious false positive result of DECT perfusion in comparison to SPECT in a 44-year-old male CAD patient. Volume-rendered DECT coronary angiography image **(a)** shows occlusion of LCX *(arrow)*. DECT perfusion short-axis view **(b)** shows perfusion defect in inferolateral wall of left ventricle in LCX territory *(dashed arrows)*. Occlusion of LCX *(bold arrow)* was confirmed on ICA **(c)**. Short-axis view of stress SPECT **(d)** did not show any perfusion defect.

that it integrates coronary artery anatomy with myocardial perfusion in a single scan. The combined morphological and functional information provided by DECT imaging could increase the cost-effectiveness of the technique in people at high-risk for CAD. DECT has the ability to become "one-stop shop" modality for diagnosis and management of CAD by integrating morphological assessment of coronary arteries with myocardial perfusion.

Conflict of interest disclosure

The authors declared no conflicts of interest.

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