Coronary CT Angiography versus Conventional Cardiac Angiography for Therapeutic Decision Making in Patients with High Likelihood of Coronary Artery Disease[1]

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Purpose: To assess the efficacy of coronary computed tomographic (CT) angiography for therapeutic decision making in patients with high likelihood of coronary artery disease (CAD)—specifically the ability of coronary CT angiography to help differentiate patients without and patients with a need for revascularization and determine the appropriate revascularization procedure.

Materials and Methods: The study protocol was approved by institutional review board, with written informed consent from all patients. The study was conducted in compliance with HIPAA. One hundred eighty-five consecutive symptomatic patients (121 men; mean age, 59.4 years ± 9.7) with a positive single photon emission computed tomography (SPECT) myocardial perfusion study underwent coronary CT angiography and conventional cardiac angiography (hereafter, cardiac catheterization). The management strategy (conservative treatment vs revascularization) and revascularization procedure (percutaneous coronary intervention [PCI] vs coronary artery bypass graft surgery [CABG]) were prospectively selected on the basis of a combination of coronary CT angiography and SPECT. In addition, the authors calculated the accuracy, sensitivity, specificity, and negative and positive predictive values of coronary CT angiography in the detection of obstructive CAD and the selection of a revascularization strategy. Cardiac catheterization was used as the standard of reference.

Results: Of the 185 patients, 113 (61%) did not undergo revascularization and 42 (23%) were free of CAD. In 178 patients (96%), the same therapeutic strategy (conservative treatment vs revascularization) was chosen on the basis of coronary CT angiography and catheterization. All patients in need of revascularization were identified with coronary CT angiography. When revascularization was indicated, the same procedure (PCI vs CABG) was chosen in 66 of 72 patients (92%).

Conclusion: In patients with high likelihood of CAD, the performance of coronary CT angiography in the differentiation of patients without and patients with a need for revascularization and the selection of a revascularization strategy was similar to that of cardiac catheterization; accordingly, coronary CT angiography has the potential to limit the number of patients without obstructive CAD who undergo cardiac catheterization and to inform decision making regarding revascularization.

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A large body of literature has demonstrated the ability of coronary computed tomographic (CT) angiography to rule out significant stenosis and has proposed this test as a noninvasive alternative to conventional cardiac angiography (hereafter, conventional cardiac catheterization) in the work-up of patients suspected of having coronary artery disease (CAD) (1–5). The ultimate goal of any diagnostic test is to establish the best therapeutic strategy for the individual patient. However, surprisingly little information is available about the role of coronary CT angiography in guiding patient treatment beyond the mere ability of this test to help detect and exclude significant coronary artery stenosis (6–8).

At the same time, the number of cardiac catheterization procedures not followed by an interventional procedure is substantial and improvements in the strategies for decision making regarding revascularization are desirable. Accordingly, the purpose of this current prospective study was to assess the efficacy of coronary CT angiography for therapeutic decision making in patients with high likelihood of CAD—specifically the ability of coronary CT angiography to help differentiate patients without and patients with a need for revascularization and determine the appropriate revascularization procedure.

Advances in Knowledge

- In patients with high likelihood of coronary artery disease, decisions made on the basis of coronary CT angiography were similar to those made on the basis of conventional cardiac catheterization with regard to differentiation of patients without and patients with a need for revascularization.
- Decisions made with a coronary CT angiography–based algorithm were similar to those made with conventional coronary catheterization with regard to the selection of an appropriate revascularization strategy.

Materials and Methods

This study was supported in part through financial research grants provided by GE Healthcare (Chalfont St Giles, England), Bracco Diagnostics (Princeton, NJ), and Siemens Healthcare (Forchheim, Germany), as well as through the Research and Development Program of the Department of Veterans Affairs. One author (U.J.S.) is a consultant for GE Healthcare, Bracco Diagnostics, Siemens Healthcare, and Medrad. The authors who are not consultants for GE Healthcare, Bracco Diagnostics, Siemens Healthcare, or Medrad had control of the data and information that might present a conflict of interest for the consultant author. The contents do not represent the views of the Department of Veterans Affairs or the U.S. Government.

Patients

In the conduct of our ongoing trials comparing coronary CT angiography and conventional cardiac catheterization, we prospectively recruited patients with nonacute chest pain (stable angina, atypical chest pain) who had been referred to our Heart & Vascular Center or our affiliated Veterans Affairs Medical Center for elective conventional cardiac catheterization. Consecutive patients who had a recent (<1 month) positive rest-stress single photon emission computed tomography (SPECT) myocardial perfusion study with a summed stress score of 9 or greater were included in this analysis. General exclusion criteria were indications for emergent or urgent cardiac catheterization (acute coronary syndromes, acute myocardial infarction, cardiogenic shock), a known history of CAD, and relative contraindications to coronary CT angiography, including a history of contrast material reactions and a serum creatinine level greater than 1.5 mg/dL. During the recruitment period, 88 potential candidates were not enrolled because of a known history of CAD with prior revascularization, 42 because of impaired renal function, 37 because of participant or physician refusal, 11 because of scheduling conflicts, and five because of a history of previous contrast material reactions. The study protocols were approved by our institutional review board, and written informed consent was obtained from all patients. The study was conducted in compliance with the Health Insurance Portability and Accountability Act.

Acquisition of Coronary CT Angiograms

Within 1 week before catheterization, all patients were examined by using a first- or second-generation dual-source CT system (Somatom Definition or Somatom Definition Flash, respectively; Siemens Healthcare, Forchheim, Germany). The coronary CT angiography technique was chosen individually for each patient depending on heart rate and/or rhythm and body mass index, with the goal of minimizing radiation exposure while maximizing diagnostic image quality. Image acquisition

Implication for Patient Care

- Coronary CT angiography has the potential to limit the number of patients without obstructive coronary artery disease who undergo conventional cardiac catheterization and to inform decision making with regard to revascularization.

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Abbreviations:
CABG = coronary artery bypass graft surgery
CAD = coronary artery disease
ECG = electrocardiography
PCI = percutaneous coronary intervention

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Guarantors of integrity of entire study, A.M., U.J.S.; study concepts/study design or data acquisition or data analysis/interpretation, all authors; manuscript drafting or manuscript revision for important intellectual content, all authors; manuscript final version approval, all authors; literature research, A.M., R.V., U.J.S., J.W.N., M.M., D.H.S., C.F., M.O., T.X.O., T.H.; clinical studies, A.M., U.J.S., P.L.Z., V.F., C.F., T.X.O., T.H.; statistical analysis, A.M., R.V., C.F., T.H.; and manuscript editing, all authors

Conflicts of interest are listed at the end of this article.

techniques included traditional retrospective electrocardiographic (ECG) gating with default use of ECG-dependent tube current modulation, prospective ECG triggering, and prospectively ECG-triggered high-pitch spiral acquisitions (9). A tube potential of 120 kV was used in patients with a body mass index of more than 25 kg/m^2, and a tube potential of 100 kV was used in patients with a body mass index of less than 25 kg/m^2. In the absence of contraindications, patients received 0.4 mg of sublingual nitroglycerin (Nitroquick; Ethex KV Pharmaceuticals, Bridgeton, Mo) before image acquisition. β-blockers (5–20-mg intravenous metoprolol tartrate [Lopressor, Novartis, East Hanover, NJ]) were used to lower heart rates to less than 65 beats per minute in patients undergoing prospectively ECG-triggered high-pitch spiral acquisitions. Contrast medium enhancement was achieved with injection of 60–90 mL of iodinated contrast material (iohexol [Omnipaque; GE Healthcare, Chalfont St Giles, England], 350 mg of iodine per milliliter; iopamidol [Isovue; Bracco Diagnostics, Princeton, NJ], 370 mg of iodine per milliliter; or iopromide [Ultravist; Bayer Healthcare, Wayne, NJ], 370 mg of iodine per milliliter) followed by 30 mL of saline, both injected at a rate of 6 mL/sec by using a dual-syringe injector (Stellant D; Medrad, Indianola, Pa).

Coronary CT Angiogram Evaluation and Therapeutic Decision Making

Coronary CT angiography data sets were transferred to an image processing workstation (Syngo MMWP VE 36A, Siemens) and jointly interpreted by two experienced observers (one radiologist [U.J.S.] and one cardiologist [P.L.Z.] with 14 and 8 years of experience in coronary CT angiography, respectively). The coronary artery tree was evaluated on a segmental basis according to the American Heart Association 15-segment model (10) by using transverse sections, curved multiplanar reformations along the vessel centerline, and automated measurement tools for the assessment of stenosis severity. Each segment was evaluated for the presence of stenosis and classified as being free of luminal narrowing or as harboring nonsignificant disease (luminal irregularities with diameter stenosis <50%) or potentially significant flow-limiting disease (diameter stenosis ≥50% in two orthogonal directions). No patients or segments were excluded from analysis. If segments were not assessable because of technical factors (eg, motion artifacts), the affected segment was considered positive for obstructive CAD for the purpose of this investigation. If more than one adjacent coronary segment was involved by stenosis, all affected segments were considered positive for obstructive CAD.

On the basis of findings at coronary CT angiography and SPECT, and without knowledge of results at subsequent cardiac catheterization, a decision was made prospectively as to whether revascularization was indicated. Revascularization was considered to be indicated in the presence of obstructive CAD, that is, when the vascular territory of a perfusion defect on SPECT scans matched the location of a potentially significant flow-limiting lesion on coronary CT angiograms. If revascularization was considered indicated, a decision was made as to whether percutaneous coronary intervention (PCI) or coronary artery bypass graft (CABG) was more appropriate on the basis of imaging findings and clinical factors and according to the American College of Cardiology/American Heart Association guidelines for coronary revascularization (11). Briefly, on the basis of imaging and medical information, patients with one- or two-vessel disease (without ostial left anterior descending coronary artery involvement) were generally considered candidates for PCI in the absence of factors suggesting a different revascularization strategy (age, medical history, risk factors, lesion location and complexity). Patients with isolated left main disease, patients with left main disease and additional stenosis elsewhere, and patients with three-vessel disease were considered candidates for CABG.

Cardiac Catheterization–based Therapeutic Decision Making

The eventual therapeutic strategy chosen at conventional cardiac catheterization served as the standard of reference for determining the accuracy of coronary CT angiography in therapeutic decision making. Cardiac catheterization was performed via the femoral or radial artery by one of three interventional cardiologists (V.F., D.H.S., and T.X.O., all with more than 8 years of experience in catheter-based coronary angiography and intervention). The angiographers were not made aware of findings at coronary CT angiography before catheterization except in cases in which that information would have an immediate effect on the interventional procedure (eg, presence of coronary artery anomalies). At least four views of the left and two views of the right coronary artery were evaluated for at least 50% diameter stenosis in at least two views by using the same 15-segment model and CAD classification strategy as for coronary CT angiography. Analogous to the decision-making process based on coronary CT angiography, cardiac catheterization findings in combination with SPECT results were used to identify obstructive CAD by means of matching the vascular territory of perfusion defects with the location of stenoses at catheterization. If revascularization was considered to be indicated, a decision was made as to whether PCI or CABG was more appropriate by using criteria identical to those described earlier. All PCI procedures were performed ad hoc.

Statistical Analysis

Statistical analyses were performed by using software (SPSS version 12.0; SPSS, Chicago, Ill). Continuous variables are presented as means ± standard deviations, and categorical variables are presented as absolute values and percentages. The diagnostic performance of coronary CT angiography in the detection of obstructive CAD (accuracy, sensitivity, specificity, and negative and positive predictive values) was assessed on a per-segment and per-patient basis, and data are presented as percentages and 95% confidence

intervals by using the combination of findings at catheterization and SPECT as the standard of reference. The performance characteristics of coronary CT angiography–based therapeutic decision making (accuracy, sensitivity, specificity, and negative and positive predictive values) were also calculated and presented as percentages and 95% confidence intervals by using the eventual treatment strategy chosen at catheterization as the standard of reference.

Results

Within an 18-month period, we screened 220 consecutive patients meeting the inclusion criteria for enrollment. Of these, 35 were not enrolled because of patient or physician refusal or scheduling conflicts. Our final study population consisted of 185 patients (121 men, 64 women; mean age, 59.4 years ± 9.7), 54% of whom were obese (Table E1 [online]). All coronary CT angiograms and catheterization studies were successfully completed without complications. The mean heart rate during CT angiography was 65 beats per minute ± 13 (range, 40–103 beats per minute). Sixty-seven patients underwent retrospectively ECG-gated CT angiography, 104 underwent prospectively ECG-triggered CT angiography, and 14 underwent prospectively ECG-triggered high-pitch spiral CT angiography, with estimated effective radiation doses of 10.3 mSv ± 4.1, 6.1 mSv ± 2.9, and 2.1 mSv ± 1.3, respectively, based on a factor of 0.014 for converting dose-length product into effective dose (12).

Prevalence of Obstructive CAD and Diagnostic Performance of Coronary CT Angiography

Thirty-six of the 2739 coronary artery segments (1.3%) were not visualized with either modality and were considered congenitally absent. Cardiac catheterization showed obstructive atherosclerotic lesions in 75 of the 185 patients (41%) and 287 of the 2739 segments (10%) (Table E2, Fig E1 [online]). One hundred ten of the 185 patients (59%) had either normal coronary arteries ($n = 42$, 23%) or nonsignificant angiographic irregularities with less than 50% luminal narrowing ($n = 68$, 37%) (Table E2 [online], Fig 1). The per-segment and per-patient performance of coronary CT angiography compared with cardiac catheterization in the detection of obstructive CAD is shown in Table 1. Twenty-six of the 2739 segments (0.9%) were deemed not evaluable at coronary CT angiography owing to motion artifacts. Twenty-three of the 185 patients (12%) had no evidence of calcified or noncalcified coronary atherosclerotic plaque at coronary CT angiography.

Table 1

Performance of Coronary CT Angiography and SPECT in the Detection of Obstructive CAD

Parameter	Per-Segment Analysis ($n = 2739$)	Per-Patient Analysis ($n = 185$)
Accuracy (%)	96.7	96.2
Sensitivity (%)	94.0 (91.3, 96.8)	100 (94.6, 100)
Specificity (%)	97.0 (96.3, 97.7)	93.6 (86.7, 96.9)
Negative predictive value (%)	99.3 (98.9, 99.6)	100 (96.3, 100)
Positive predictive value (%)	78.7 (74.4, 83.0)	91.5 (82.6, 95.9)
No. of true-positive findings	270	75
No. of false-positive findings	73	7
No. of true-negative findings	2379	103
No. of false-negative findings	17	0

Note.—Numbers in parentheses are 95% confidence intervals. The combination of findings at conventional cardiac catheterization and SPECT was used as the standard of reference.

Therapeutic Decision Making

In the 42 patients with angiographically normal coronary arteries, no specific treatment was instituted beyond measures of primary disease prevention and risk factor modification. Among the 143 patients with an angiographic diagnosis of CAD, a decision to treat conservatively with optimized medical therapy was made in 71 patients, whereas revascularization was performed in 72 of the 75 patients with obstructive CAD (Fig 2). In three patients with obstructive one-vessel disease, flow-limiting lesions were located in small distal branches that were deemed not amenable to revascularization (Fig E1 [online]).

Coronary CT angiography enabled us to correctly exclude obstructive CAD in all 42 patients with angiographically normal coronary arteries. In the 143 patients with an angiographic diagnosis of CAD, the therapeutic strategy selected with CT angiography was in agreement with that selected with catheterization in 136 patients (95%); revascularization therapy was incorrectly considered to be indicated in seven patients who had no significant stenosis at catheterization. Thus, overall, coronary CT angiography enabled us to correctly differentiate patients without and patients with a need for revascularization in 178 of 185 patients (96%) (Table 2).

Of the 72 patients with obstructive CAD who were deemed amenable to revascularization on the basis of cardiac catheterization, 41 underwent PCI and 31 were referred for CABG. The appropriate revascularization therapy was chosen with use of coronary CT angiography in 66 of the 72 patients (92%). In five patients who eventually underwent PCI, CABG was incorrectly selected as the most appropriate revascularization procedure on the basis of coronary CT angiography owing to overestimation of lesion severity. In addition, one patient who eventually underwent CABG was incorrectly classified as a candidate for PCI with two-vessel disease because of a missed significant stenosis in a third vessel (Table 2).

Discussion

In this prospective study, we showed that, in a cohort of patients with a positive SPECT study who were clinically

Figure 1

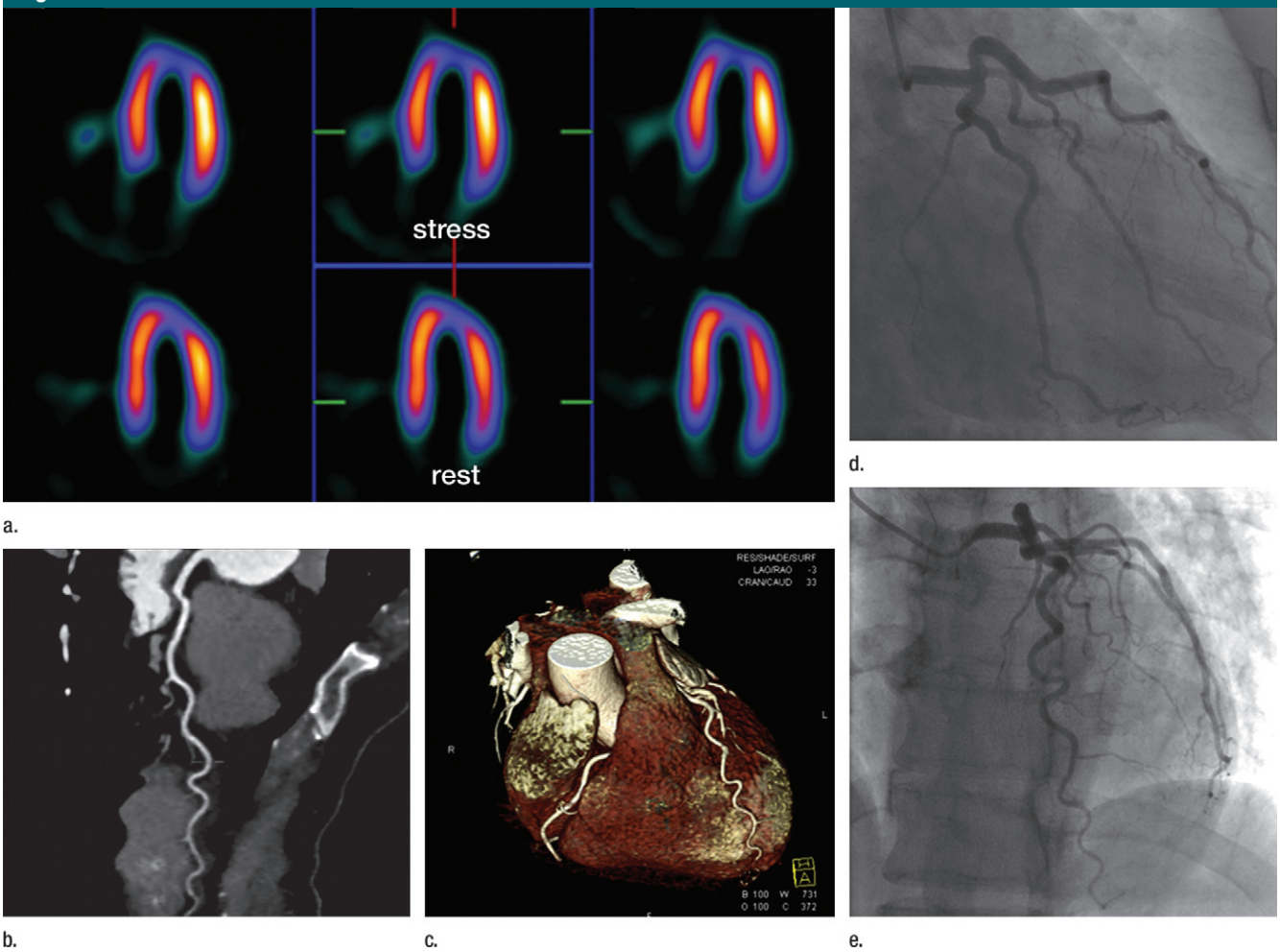

Figure 1: Images in 54-year-old man with atypical chest pain. **(a)** Myocardial perfusion SPECT scans obtained at rest (bottom) and after stress (top) show fixed perfusion defect in apical anterior wall. **(b, c)** Contrast material–enhanced ECG-synchronized coronary CT angiograms obtained after SPECT and displayed as **(b)** automatically generated curved multiplanar reformation and **(c)** three-dimensional volume-rendered image show unremarkable coronary arteries without atherosclerotic changes. **(d, e)** Images from conventional cardiac catheterization performed after SPECT and CT in **(d)** left and **(e)** right anterior oblique projections show unremarkable coronary arteries, confirming findings at coronary CT angiography.

considered to need conventional cardiac catheterization, decisions made with coronary CT angiography with regard to the differentiation of patients with and patients without a need for revascularization and the selection of an appropriate revascularization strategy were similar to those made with cardiac catheterization. As such, coronary CT angiography has the potential to act as an effective secondary gatekeeper after a positive nuclear myocardial perfusion study, limiting the number of patients without obstructive CAD who undergo conventional cardiac catheterization and informing decision making with regard to revascularization.

The composition of our cohort very closely mirrors the demographics, risk factors, and symptoms of the general patient population that undergoes elective cardiac catheterization at U.S. institutions (13). There was a greater proportion of men in our cohort, which may be explained by our partial recruitment from the Veterans Affairs System population, and a slightly higher prevalence of obstructive CAD, likely because we solely focused on patients with previous positive SPECT studies. Despite this, the prevalence of obstructive CAD was relatively low, with flow-obstructing lesions found in only 41% of our patients.

The performance parameters of coronary CT angiography in this study, with a per-patient sensitivity and specificity of 100% and 93.6%, respectively, are consistent with the results of previous investigations that have demonstrated the strong performance of coronary CT angiography as a noninvasive alternative to conventional cardiac catheterization for the detection and exclusion of obstructive CAD (1–5,14).

Figure 2

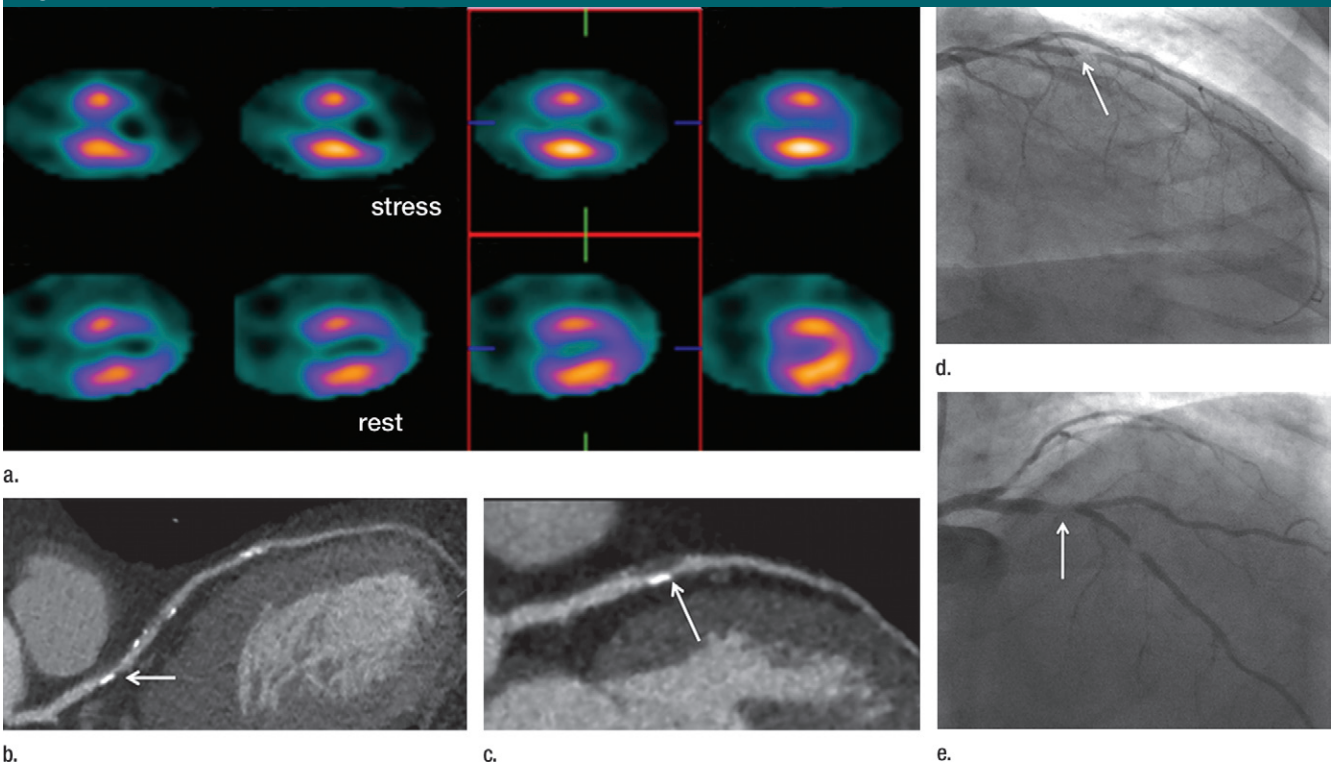

Figure 2: Images in 66-year-old man with stable angina. **(a)** Myocardial perfusion SPECT scans obtained at rest (bottom) and after stress (top) show a partially reversible perfusion defect in anterior wall. **(b, c)** Contrast-enhanced ECG-synchronized coronary CT angiograms obtained after SPECT and displayed as curved multiplanar reformations of left anterior descending coronary artery show obstructive lesion (arrow) composed of calcified and noncalcified atherosclerotic plaque in proximal portion of vessel. **(d, e)** Images from conventional cardiac catheterization performed after SPECT and CT in **(d)** right anterior oblique and **(e)** right anterior oblique cranial projections show flow-obstructing lesion (arrow) in proximal portion of left anterior descending artery, confirming findings at coronary CT angiography.

Table 2

Performance of Coronary CT Angiography in Determining the Appropriate Treatment Strategy

Parameter	Patients with CAD (n = 143)	All Patients (n = 185)
Accuracy (%)	95.1	96.2
Sensitivity (%)	100 (94.6, 100)	100 (95.7, 100)
Specificity (%)	90.1 (83.2, 97.0)	93.8 (89.3, 98.2)
Negative predictive value (%)	100 (93.9, 100)	100 (96.5, 100)
Positive predictive value (%)	91.1 (84.8, 97.4)	91.1 (84.8, 97.4)
No. of true-positive findings	72	72
No. of false-positive findings	7	7
No. of true-negative findings	64	106
No. of false-negative findings	0	0

Note.—Numbers in parentheses are 95% confidence intervals. Conventional cardiac catheterization was used as the standard of reference.

Our findings also confirm the relatively low specificity of clinical decision making based on an abnormal SPECT myocardial perfusion imaging studies, as 59% of patients referred for cardiac catheterization on the basis of positive SPECT studies did not have obstructive CAD. Thus, in our population, the diagnostic performance of rest-stress myocardial perfusion SPECT was moderately lower than that reported in the meta-analyses by Fleischmann et al (15) and Heijenbrok-Kal et al (16), who showed pooled sensitivities of 87% and 88% and specificities of 64% and 73%, respectively. The somewhat lower performance of SPECT in our cohort compared with these meta-analyses may be explained by the fact that SPECT had been performed at a variety of facilities other than our own with use of varying equipment and techniques rather than in a standardized fashion at a single institution with state-of-the-art scanners, with decisions to proceed to cardiac catheterization made independently by various clinicians. Although this may be seen as a limitation of our study, it also reflects the realities of patient care in the United States, where patients with positive findings at noninvasive testing

are only moderately more likely to have a flow-obstructing lesion than those who do not undergo any testing (13). Similarly, we defined abnormal stress tests for inclusion in the study as a summed stress score of 9 or greater. Although this abnormality is clinically significant, it does not necessarily imply that the defect is anatomically congruent over segments, the defect is reversible (indicative of ischemia), or the defect is not the result of artifact. As such, the predictive value of the summed stress score alone is somewhat limited. Nevertheless, because any abnormal stress test often leads to referral for cardiac catheterization, this limitation does not necessarily mitigate the validity of our findings but rather confirms the potentially important role of coronary CT angiography as a secondary gatekeeper, as investigated in this study, for clarifying and adding greater specificity to abnormal nuclear myocardial perfusion studies. Furthermore, the notion that ours is a real-life experience is corroborated by the 41% prevalence of obstructive CAD, which matches exactly the value reported for the general population undergoing cardiac catheterization after a positive result at noninvasive testing (13).

In our study, 12% of patients with positive findings at SPECT had no discernible coronary atherosclerosis and 23% had angiographically normal vessels. Sixty-one percent did not undergo revascularization and, presumably, the benefit from cardiac catheterization was the exclusion of CAD and the optimization of medical therapy, which coronary CT angiography could also provide. Coronary CT angiography correctly excluded obstructive CAD in all 42 patients with angiographically normal vessels at catheterization. Coronary CT angiography helped correctly predict the need for revascularization in 95% of patients with an angiographic diagnosis of CAD and the eventual revascularization procedure in 92% of cases. These parameters suggest excellent performance and safety of coronary CT angiography for therapeutic decision making in patients suspected of having CAD. Importantly, all patients in need of revascularization were identified with coronary CT angiography. The number of patients with false-positive findings who were incorrectly received a diagnosis of obstructive CAD and in whom cardiac catheterization was not followed by intervention was rather low (n = 7). These findings indicate the strong potential for reducing unnecessary diagnostic catheterization procedures if coronary CT angiography is integrated into the diagnostic algorithm of suspected CAD. This effect was previously demonstrated by Chow et al (17), who showed that clinical implementation of coronary CT angiography reduces the frequency of inconsequential catheterization studies.

In our investigation, coronary CT angiography had an overall accuracy of 96% for indicating the need for revascularization. These results are in contrast with those from a study by Piers et al (8), who reported that coronary CT angiography helped correctly predict interventional versus conservative therapy in only 47 of their 60 patients (78%). Piers et al also reported that coronary CT angiography helped predict the appropriate revascularization procedure (PCI vs CABG) in only 26 of 37 patients (70%); in our study, coronary CT angiography–based decisions were accurate in more than 90% of patients. This difference may be partly explained by the higher prevalence of obstructive CAD in the study by Piers et al. More importantly, investigators were blinded to the results of previous testing whereas we made decisions with use of all available patient information before cardiac catheterization to better simulate clinical decision making. Accordingly, Piers et al investigated the role of coronary CT angiography as a primary gatekeeper before catheterization, whereas we evaluated the efficacy of this test as a secondary gatekeeper after a positive finding at SPECT. As such, our study is more comparable to the investigation by Gaemperli et al (6), who reported that a combined noninvasive approach with coronary CT angiography and SPECT had 100% accuracy for detecting obstructive CAD. Compared with our investigation, their study population was smaller (n = 78) and more heterogeneous, including asymptomatic patients, patients with known CAD, and patients with negative SPECT studies (60%), whereas we exclusively recruited symptomatic patients without known CAD but with positive SPECT results. These authors do not specifically report accuracies for predicting the eventual therapeutic strategy, likely because of the considerable proportion of patients in their cohort without obstructive CAD who underwent intervention (53%).

In this investigation, as in our clinical practice, coronary CT angiography protocols were designed to minimize radiation and maximize diagnostic image quality in each individual patient. Because no formal randomization to specific image acquisition protocols was performed, there could be some potential bias on the basis of a variety of factors that cannot be accounted for by our study design. Our study is still limited by a relatively small population, although our cohort is considerably more sizable than that in previous investigations (6,8). Larger-scale multicenter studies, which are currently under way, are required to confirm our results and to investigate patient outcomes and cost-effectiveness of coronary CT angiography–based therapeutic decision making in patients with high likelihood of CAD.

In conclusion, our findings demonstrate that, in patients with high likelihood of CAD, coronary CT angiography may be an effective secondary gatekeeper for clarifying abnormal SPECT findings. The performance of a coronary CT angiography–based algorithm in the differentiation of patients with and patients without the need for revascularization and the selection of a revascularization strategy was similar to that of conventional coronary catheterization; these findings suggest that coronary CT angiography might have an important role in the efforts to reduce the number of unnecessary invasive diagnostic procedures and in in forming decision making regarding re vascularization.

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