

Circulation (2004);109:14-7

Detection of calcified and noncalcified coronary atherosclerotic plaque by contrast-enhanced, submillimeter multidetector spiral computed tomography: a segment-based comparison with intravascular ultrasound

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**BACKGROUND:** We investigated the ability of multidetector spiral computed tomography (MDCT) to detect atherosclerotic plaque in nonstenotic coronary arteries.

**METHODS AND RESULTS:** In 22 patients without significant coronary stenoses, contrast-enhanced MDCT (0.75-mm collimation, 420-ms rotation) and intravascular ultrasound (IVUS) of one coronary artery were performed. A total of 83 coronary segments were imaged by IVUS (left main, 19; left anterior descending, 51; left circumflex, 4; right coronary, 9). MDCT data sets were evaluated for the presence and volume of plaque in the coronary artery segments. Results were compared with IVUS in a blinded fashion. For the detection of segments with any plaque, MDCT had a sensitivity of 82% (41 of 50) and specificity of 88% (29 of 33). For calcified plaque, sensitivity was 94% (33 of 36) and specificity 94% (45 of 47). Coronary segments containing noncalcified plaque were detected with a sensitivity of 78% (35 of 45) and specificity of 87% (33 of 38), but presence of exclusively noncalcified plaque was detected with only 53% sensitivity (8 of 15). If analysis was limited to the 41 proximal segments (segments 1, 5, 6, and 11 according to American Heart Association classification), sensitivity and specificity were 92% and 88% for any plaque, 95% and 91% for calcified plaque, and 91% and 89% for noncalcified plaque. MDCT substantially underestimated plaque volume per segment as compared with IVUS (24+/-35 mm<sup>3</sup> versus 43+/-60 mm<sup>3</sup>, P<0.001). **CONCLUSIONS:** The results indicate the potential of MDCT to detect coronary atherosclerotic plaque in patients without significant coronary stenoses. However, further improvements in image quality will be necessary to achieve reliable assessment, especially of noncalcified plaque throughout the coronary tree.  
[http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Citation&list\\_uids=14691045](http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Citation&list_uids=14691045)

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Assessment of coronary remodeling in stenotic and nonstenotic coronary atherosclerotic lesions by multidetector spiral computed tomography

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**OBJECTIVES:** This study was designed to investigate whether contrast-enhanced multidetector spiral CT (MDCT) permits assessment of remodeling in coronary atherosclerotic lesions. **BACKGROUND:** With sufficient image quality, MDCT permits noninvasive visualization of the coronary arteries, but its ability to assess remodeling has not been evaluated. **METHODS:** Out of 102 patients in whom MDCT (16-slice scanner, intravenous contrast, 0.75-mm collimation, 420 ms rotation) was performed before invasive coronary angiography, 44 patients with high-quality MDCT data sets showing atherosclerotic plaque in a proximal coronary artery segment were chosen for evaluation. In multiplanar reconstructions orthogonal to the coronary artery, the

cross-sectional vessel area was measured for the respective lesion and for a reference segment proximal to the lesion. The "Remodeling Index" was calculated by dividing the vessel area in the lesion by the reference segment. Results were correlated to the presence of stenosis (>50% diameter reduction) in invasive angiography. In a subset of 13 patients, MDCT measurements were verified by IVUS. RESULTS: Reference vessel area was not significantly different between nonstenotic versus stenotic lesions (20 +/- 8 mm<sup>2</sup>, n = 23 vs. 22 +/- 8 mm<sup>2</sup>, n = 21). The mean Remodeling Index was significantly higher in nonstenotic than in stenotic lesions (1.3 +/- 0.2 vs. 1.0 +/- 0.2, p < 0.001). In five stenotic lesions, "negative remodeling" (Remodeling Index < or = 0.95) was observed. Cross-sectional vessel areas and Remodeling Indices measured by MDCT correlated closely to IVUS (r(2) = 0.77 and r(2) = 0.82, respectively). CONCLUSIONS: Multidetector spiral CT may permit assessment of remodeling of coronary atherosclerotic lesions in selected data sets of sufficient quality.  
[http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Citation&list\\_uids=14998627](http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Citation&list_uids=14998627)

Am J Cardiol (2004);94:1590-3

Standard versus user-interactive assessment of significant coronary stenoses with multislice computed tomography coronary angiography

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Forty-four patients in sinus rhythm with suspected coronary artery disease underwent 16-row multislice computed tomography coronary angiography and conventional coronary angiography. Two protocols for image analysis were applied to the multislice computed tomographic images: standard projections versus interactive postprocessing. The diagnostic accuracy of both methods for the detection of significant lesions (>50% lumen reduction) was compared with quantitative coronary angiography. Sensitivity and specificity were 58% and 96% and 96% and 97%, for standard projections and interactive postprocessing protocol, respectively.

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Am J Cardiol (2004);94:99-104

Characterization of vulnerable nonstenotic plaque with 16-slice computed tomography compared with intravascular ultrasound

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We compared 16-slice computed tomography with intravascular ultrasound in the detection of unstable component characteristics of nonstenotic plaque responsible for acute coronary syndrome. Computed tomography accurately assessed plaque eccentricity, calcification, and remodeling, and intraplaque hypodensity correlated with intravascular ultrasound echolucent area.

[http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Citation&list\\_uids=15219516](http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Citation&list_uids=15219516)

Am J Cardiol (2004);94:967-9

Usefulness of multislice computed tomography angiography to evaluate intravascular stents and transcatheter occlusion devices in patients with d-transposition of the great arteries after mustard repair

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Percutaneous interventions can treat long-term complications after Mustard atrial switch operation in patients with d-transposition of the great arteries (d-TGA), but follow-up for these procedures has not been established. Four patients with d-TGA and previous Mustard operation underwent percutaneous placement of covered stents to relieve superior and inferior vena caval baffle obstructions and leaks. At 6 to 13 months, assessment with 16-slice spiral computed tomography identified stent patency as well as lead placement and visualization of additional devices.

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Am J Cardiol (2004);94:348-51

Epidemiology and association of vascular and valvular calcium quantified by multidetector computed tomography in elderly asymptomatic subjects

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The epidemiology of and association between vascular and valvular calcium as quantified by multidetector computed tomography (MDCT) were studied in 416 elderly subjects with no history of coronary artery disease. Coronary calcium (CC), descending thoracic aortic calcium (DTAC), aortic valve calcium (AVC), and mitral valve calcium (MVC) were present in 282 (68%), 214 (51%), 152 (37%), and 68 (16%) subjects, respectively. Multiple logistic regression analysis showed that after adjusting for age and gender, subjects with AVC (odds ratio [OR] 2.3), MVC (OR 2.81), and DTAC (OR 2.79) were independently and significantly more likely to have CC. Further evidence is provided for the notion that calcifications in those regions are associated and that MDCT can be used as a tool for the global assessment of vascular and valvular calcium.

[http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Citation&list\\_uids=15276102](http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Citation&list_uids=15276102)

Am J Cardiol (2005);95:1 Lemvy5tn-5.apn9and D8 analyr ar twere present in 2841 Tw[8 present in 7-.0

electrocardiographic gating, images and cine movies were reconstructed, which allowed 2 independent observers to analyze the 9 major coronary artery segments and global/regional LV function. Conventional angiography (with quantitative analysis) and echocardiography served as standards of reference, which were performed  $\leq 2 \pm 2.7$  days and  $\leq 3$  hours, respectively, after multidetector-row computed tomographic investigations. Sensitivity, specificity, positive and negative predictive values, and correlations were calculated. Of 225 coronary artery segments, 182 (81%) were assessable by MDCT. Significant ( $\geq 50\%$ ) coronary artery stenosis was detected with sensitivities, specificities, and positive and negative predictive values of 95%, 91%, 85%, and 97% for observer 1 and 89%, 87%, 79%, and 94% for observer 2, respectively; the interobserver kappa value was 0.73. MDCT showed excellent agreement with echocardiography for regional wall motion (90%; kappa = 0.88) and LV ejection fraction (correlation 0.95%, mean difference 0.7  $\pm$  3.9). Thus, MDCT can simultaneously assess coronary artery disease and LV function in patients who have unstable angina. High accuracies in excluding significant coronary artery disease and in confirming normal LV function were observed, suggesting potential clinical use for screening of patients who present with symptoms of unstable angina.  
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Am J Cardiol (2005);95:110-2

Noninvasive assessment of left main coronary stent patency with 16-slice computed tomography

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We investigated the ability of 16-slice computer tomography (CT) to discriminate any restenosis after left main coronary artery stenting in 29 consecutive patients. CT was able to detect all stents and analyze the lumen properly in 27 of 29 cases. With the exception of arrhythmic or heavily calcified segments, multislice CT provides a noninvasive alternative to conventional coronary angiography in the follow-up of left main angioplasty with stenting.

[http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Citation&list\\_uids=15619405](http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Citation&list_uids=15619405)

Am J Cardiol (2004);93:101-3

Relation of response of subclinical atherosclerosis detected by electron beam tomography to baseline low-density lipoprotein cholesterol levels

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Calcified plaque progression by electron beam tomography was evaluated in 176 aggressively treated asymptomatic patients. Similar plaque progression was noted irrespective of baseline low-density lipoprotein cholesterol levels, including those with low-density lipoprotein cholesterol  $< 100$  mg/dl. These findings indicate that subclinical atherosclerosis may respond to drug therapy in a fashion parallel to that of clinical disease demonstrated in the Heart Protection Study.

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Predictive value of 16-slice multidetector spiral computed tomography to detect significant obstructive coronary artery disease in patients at high risk for coronary artery disease: patient-versus segment-based analysis

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**BACKGROUND:** In this study, we investigated the diagnostic value and limitations of multidetector computed tomography (MDCT)-based noninvasive detection of significant obstructive coronary artery disease (CAD) in a consecutive high-risk patient population with inclusion of all coronary segments. **METHODS AND RESULTS:** In a prospective, blinded, standard cross-sectional technology assessment, a cohort of 33 consecutive patients with a positive stress test result underwent 16-slice MDCT and selective coronary angiography for the detection of significant obstructive CAD. We assessed the diagnostic accuracy of MDCT in a segment-based and a patient-based model and determined the impact of stenosis location and the presence of calcification on diagnostic accuracy in both models. Analysis of all 530 coronary segments demonstrated moderate sensitivity (63%) and excellent specificity (96%) with a moderate positive predictive value of 64% and an excellent negative predictive value (NPV) of 96% for the detection of significant coronary stenoses. Assessment restricted to either proximal coronary segments or segments with excellent image quality (83% of all segments) led to an increase in sensitivity (70% and 82%, respectively), and high specificities were maintained (94% and 93%, respectively). In a patient-based model, the NPV of MDCT for significant CAD was limited to 75%. Coronary calcification was the major cause of false-positive findings (94%). **CONCLUSIONS:** For all coronary segments included, 16-slice MDCT has moderate diagnostic value for the detection of significant obstructive coronary artery stenosis in a population with a high prevalence of CAD. The moderate NPV of patient-based detection of CAD suggests a limited impact on clinical decision-making in high-risk populations.

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J Am Coll Cardiol (2004);43:831-9

Diagnostic accuracy of multidetector computed tomography coronary angiography in patients with angiographically proven coronary artery disease

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(mean time 24 months postangiography). Total calcium score and all coronary arteries, including distal segments and side branches, were assessed with respect to evaluability, presence of high-grade coronary artery stenoses (>70%), and correct diagnosis. Results were compared to CCA. RESULTS: A total of 105 lesions were detected by CCA. The MDCT correctly detected 39 lesions (sensitivity 37%, specificity 99%). The correct clinical diagnosis could be obtained in 24 patients (36%). Artifacts due to elevated heart rates or severe coronary artery calcification were the main cause of degraded image quality inhibiting correct diagnosis. In 21/66 patients (32%) all four major coronary vessel segments could be visualized. A threshold for maximum heart rate and a maximum calcification level were established (65 beats/min and an Agatston Score Equivalent of 335, respectively). A second analysis was made using these thresholds. Of all patients studied, 10/11 (91%) were correctly diagnosed when adhering to these thresholds. CONCLUSIONS: When using MDCT as a noninvasive diagnostic modality to assess advanced CAD, it appears to be mandatory to preselect patients in order to achieve reliable results.

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J Am Coll Cardiol (2004);44:1230-7

Noninvasive detection of coronary lesions using 16-detector multislice spiral computed tomography technology: initial clinical results

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OBJECTIVES: The aim of our study was to evaluate the feasibility of detecting coronary artery lesions using a new computed tomography (CT) scanner with 16 detectors and faster gantry rotation. BACKGROUND: Computed tomography angiography of the coronaries permits assessment of the coronaries; however, image quality is still impaired by motion artifacts and calcifications. METHODS: Sixty patients scheduled for conventional coronary angiography (CCA) were additionally studied by multislice spiral computed tomography (MSCT). Calcium scores and a contrast-enhanced visualization of the coronaries were performed and analyzed regarding evaluability, presence of

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Accuracy of multidetector spiral computed tomography in identifying and differentiating the composition of coronary atherosclerotic plaques: a comparative study with intracoronary ultrasound

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**OBJECTIVES:** We evaluated the accuracy of contrast-enhanced multidetector spiral computed tomography (MDCT) for the noninvasive detection and classification of coronary plaques and compared it with intracoronary ultrasound (ICUS).

**BACKGROUND:** Noninvasive determination of plaque composition and plaque burden may be important to improve risk stratification and to monitor progression of coronary atherosclerosis. **METHODS:** We included 46 consecutive patients with a distinctive risk profile, who were investigated by ICUS (Goldvision, 20 MHz, Jomed Inc., Rancho Cordova, California). Due to the inability to slow the heart rate below 65 beats/min (n = 7) and due to renal insufficiency (n = 2), nine of 46 consecutive patients could not be studied by MDCT (Sensation 16, Siemens, Forchheim, Germany). **RESULTS:** In the remaining 37 patients, 68 vessels were investigated by ICUS, and 58 of these vessels were visualized by MDCT with image quality sufficient for analysis. In these vessels that were divided in 3-mm sections, MDCT correctly classified 62 of 80 (78%) sections containing hypoechoic plaque areas, 87 of 112 (78%) sections containing hyperechoic plaque areas, and 150 of 158 (95%) sections containing calcified plaque tissue. In 484 of 525 (92%) sections, atherosclerotic lesions were correctly excluded. The MDCT-derived density measurements within coronary lesions revealed significantly different values for hypoechoic (49 HU [Hounsfield Units] +/- 22), hyperechoic (91 HU +/- 22), and calcified plaques (391 HU +/- 156, p < 0.02). **CONCLUSIONS:** This study demonstrates that, in the case of diagnostic image quality, contrast-enhanced MDCT permits an accurate identification of coronary plaques and that computed tomography density values measured within plaques reflect echogenicity and plaque composition.  
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Eur Heart J (2004);25:1043-8

Accuracy of thin-slice computed tomography in the detection of coronary stenoses

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**AIM:** Our aim was to investigate the accuracy of multislice spiral computed tomography (MSCT) in the detection of significant (>50%) coronary stenosis using a scanner equipped for 16 x 0.625 mm collimation. **METHODS:** In 64 patients (59 male, mean age 58 +/- 5 years) with suspected coronary artery disease, MSCT (GE Light Speed-16, collimation: 16 x 0.625 mm) was performed 20 +/- 5 days before coronary angiography (CAG). Only angiographic segments >1.5 mm were considered for analysis. **RESULTS:** In all patients, MSCT was carried out without complications. Three patients were

98%. Including all segments in the analysis (evaluatable and nonevaluatable), sensitivity was 78%. CONCLUSIONS: Using a scanner with a collimation of 16 x 0.625 mm, our study confirms the potential role of MSCT in the detection of significant coronary stenosis with a sensitivity of 89% and a very high specificity (98%). Exclusion criteria and less than full evaluability of the coronary arteries must still be considered limitations of the method.

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Circulation (2004);110:3234-8

Evaluation of venous and arterial conduit patency by 16-slice spiral computed tomography

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BACKGROUND: Computed tomography has been shown to be useful in the evaluation of aortocoronary bypass grafts (CABG). This is the first prospective study to evaluate the accuracy of a new-generation scanner in the detection of patency and significant stenoses (>50% decrease in diameter) of venous and arterial grafts in patients with previous CABG. METHODS AND RESULTS: In 96 patients (80 males, mean age 62 years) with previous CABG, a multislice computed tomography (MSCT) scan was performed (collimation 16x0.625 mm). Patients with atrial fibrillation, renal failure, severe respiratory disease, severe heart failure, heart rate >70 bpm despite therapy, or unstable angina were excluded. A total of 285 conduits implanted on the native coronary arteries at the time of CABG were evaluated. MSCT data were analyzed by 2 independent radiologists and compared with the results of conventional angiography. Three patients were excluded from analysis. All conduits were judged evaluatable in 84 patients. Among these patients, MSCT correctly diagnosed 54 occluded grafts and 4 significant stenoses on the body of the grafts. Of the 17 significant anastomotic lesions, MSCT correctly diagnosed 15. For these 84 patients, diagnostic accuracy was 99%, sensitivity was 97%, and specificity was 100%. When all 93 patients were considered, the sensitivity of MSCT in diagnosing significant stenoses was 96%. CONCLUSIONS: MSCT with the new-generation scanner allows for accurate assessment of venous and arterial conduits in patients with previous CABG with a high degree of sensitivity and specificity. Exclusion criteria and radiation exposure remain limitations of the method. [http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Citation&list\\_uids=15533862](http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Citation&list_uids=15533862)

Circulation (2004);110:356-62

Evaluation and clinical implications of aortic valve calcification measured by electron-beam computed tomography

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BACKGROUND: Electron-beam computed tomography (EBCT) is used to measure coronary calcification but not for aortic valve calcification (AVC). Its accuracy, association with aortic stenosis (AS) severity, and diagnostic and prognostic value with



the AVC score by EBCT (1125±1294 Agatston units [AU]) showed a strong linear correlation ( $r=0.96$ ,  $P<0.0001$ ) with valvular calcium weight (653±748 mg) by pathology that allowed estimation of calcium weight as AVC score/1.7, with a small standard error of the estimate (53 mg). In 100 consecutive clinical patients, we measured AVC by EBCT and AS severity by echocardiographic aortic valve area (AVA). The AVC score was 1316±1749 AU (range 0 to 7226 AU). Intraobserver and interobserver variabilities were excellent (4±4% and 4±10%, respectively). AVC and AVA were strongly associated ( $r=0.79$ ,  $P<0.0001$ ) but had a curvilinear relationship that suggested that AVC and AVA provide complementary information. AVC score  $\geq 1100$  AU provided 93% sensitivity and 82% specificity for diagnosis of severe AS (AVA  $< 1$  cm<sup>2</sup>), with a receiver operator characteristic curve area of 0.89. AVC assessment by echocardiography was often more severe than by EBCT ( $P<0.0001$ ). During follow-up, 22 patients either died, developed heart failure, or required surgery. With adjustment for age, sex, symptoms, ejection fraction, and AVA, the AVC score was independently predictive of event-free survival (risk ratio 1.06 per 100-AU increment [1.02 to 1.10],  $P<0.001$ ), even after adjustment for echocardiographic calcifications. CONCLUSIONS: AVC is accurately and reproducibly measured by EBCT and shows a strong association and diagnostic value for severe AS. The curvilinear relationship between AVC and AVA suggests these measures are complementary, and indeed, AVC provides independent outcome information. Thus, AVC is an important measurement in the evaluation of patients with AS.

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J Am Coll Cardiol (2004);43:2265-70

Multislice spiral computed tomography coronary angiography in patients with stable angina pectoris

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OBJECTIVES: This study was designed to prospectively evaluate the diagnostic performance of multislice spiral computed tomography (MSCT) coronary angiography for the detection of significant lesions in all segments of the coronary tree potentially suitable for revascularization. BACKGROUND: Noninvasive MSCT coronary angiography is a promising coronary imaging technique. METHODS: Sixteen-row MSCT coronary angiography was performed in 128 patients (89% men, mean age 58.9 ± 11.7 years) in sinus rhythm with stable angina pectoris scheduled for conventional coronary angiography. Sixty percent (77 of 128) of patients received pre-scan oral beta-blockers, resulting in a mean d2(c)-0.0001 Tcctieo5c7Cardiol (2004);437 TcentJ A,7(y wa3(p)Tce

All patients with and 86% (18 of 21) of patients without significant lesions on QCA were correctly classified by MSCT. All patients with significant left main disease or total occlusions were correctly identified on MSCT. CONCLUSIONS: Sixteen-row MSCT coronary angiography permits reliable detection of significant obstructive coronary artery disease in patients with stable angina in sinus rhythm.

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Am J Cardiol (2004);93:1146-9

Coronary artery calcium volume scores on electron beam tomography in 12,936 asymptomatic adults

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We developed age- and gender-specific normative tables of calcium volume scores by using data from 12,936 asymptomatic patients who underwent electron beam tomographic scanning and compared the volume with the Agatston scores obtained in the same subjects. The 2 scores increased as the number of atherosclerotic risk factors increased. The volume scores were statistically smaller than the Agatston scores at the upper quartile level.

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Am J Cardiol (2004);94:202-6

Lack of usefulness of electron beam computed tomography for detecting coronary allograft vasculopathy

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Fifty-five patients with cardiac allografts were studied by electron beam computed tomography for coronary calcification (EBCT CC) and coronary arteriography, and from the latter, a coronary index was calculated using the size, degree of obstruction, and linear extent of disease of each vessel. There was a significant correlation between EBCT CC score and coronary index, but receiver-operating characteristic (ROC) analysis demonstrated unsatisfactory performance of EBCT CC, and 6 patients had no coronary calcification despite having very abnormal coronary indexes. There are pathologic differences between coronary allograft vasculopathy and atherosclerosis, and correspondingly, EBCT CC has limited usefulness in the cardiac transplant population.

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Noninvasive visualization of coronary artery bypass grafts using 16-detector row computed tomography

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specificity for the detection of persistent stenosis were 75% and 96%, respectively. In conclusion, MSCT may be useful in the assessment of stent patency and may function as a gatekeeper before invasive diagnostic procedures.

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