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Prognostic Value of Multislice Computed Tomography Coronary Angiography in Patients With Known or Suspected Coronary Artery Disease

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Objectives This study sought to determine the prognostic value of multislice computed tomography (MSCT) coronary angiography in patients with known or suspected coronary artery disease (CAD).

Background It is expected that MSCT will be used increasingly as an alternative imaging modality in the diagnosis of patients with suspected CAD. Data on the prognostic value of MSCT, however, are currently not available.

Methods A total of 100 patients (73 men, age 59 ± 12 years) who were referred for further cardiac evaluation due to suspicion of significant CAD underwent additional MSCT coronary angiography to evaluate the presence and severity of CAD. Patients were followed up for the occurrence of: 1) cardiac death, 2) nonfatal myocardial infarction, 3) unstable angina requiring hospitalization, and 4) revascularization.

Results Coronary plaques were detected in 80 (80%) patients. During a mean follow-up of 16 months, 33 events occurred in 26 patients. In patients with normal coronary arteries on MSCT, the first-year event rate was 0% versus 30% in patients with any evidence of CAD on MSCT. The observed event rate was highest in the presence of obstructive lesions (63%) and when obstructive lesions were located in the left main (LM)/left anterior descending (LAD) coronary arteries (77%). Nonetheless, an elevated event rate was also observed in patients with nonobstructive CAD (8%). In multivariate analysis, significant predictors of events were the presence of CAD, obstructive CAD, obstructive CAD in LM/LAD, number of segments with plaques, number of segments with obstructive plaques, and number of segments with mixed plaques.

Conclusions Multislice computed tomography coronary angiography provides independent prognostic information over baseline clinical risk factors in patients with known and suspected CAD. An excellent prognosis was noted in patients with a normal MSCT. (J Am Coll Cardiol 2007;49:62–70) © 2007 by the American College of Cardiology Foundation

In patients presenting with suspected or known coronary artery disease (CAD), assessment of prognosis is essential in selecting appropriate patient management. Currently, extensive data are available on the prognostic value of myocardial perfusion imaging with single-photon emission computed tomography (SPECT). A normal SPECT study has been shown to indicate a good clinical outcome with an annual death or infarct rate of <1% per year, whereas the likelihood to develop cardiac events is significantly increased when perfusion abnormalities are detected (1,2). Similarly, coronary artery calcium score assessed by electron beam computed tomography (EBCT) or, less frequently, by multislice computed tomography (MSCT), has been used for risk stratification in patients with known or suspected CAD, and a calcium score <100 has been associated with excellent outcome, with an increase in the event rate paralleling the increase in calcium score (3,4).

More recently, noninvasive coronary angiography techniques (magnetic resonance imaging, EBCT, and MSCT) have been introduced which allow direct visualization of coronary artery lesions. At present, MSCT appears to be the most robust technique for this purpose, and it is expected

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that this technique will be increasingly used as an alternative first-line imaging modality in the diagnosis of patients presenting with chest pain suspect for CAD. Multislice computed tomography allows detection of both obstructive and nonobstructive lesions, and noncalcified lesions are also visualized. Although the diagnostic accuracy of MSCT has been demonstrated, data on the prognostic value of MSCT are not available. Accordingly, the aim of this study was to determine the prognostic value of MSCT in patients with known or suspected CAD.

Methods

Patients and study protocol. The study population consisted of consecutive patients who presented to the outpatient clinic and were referred for further evaluation (using exercise electrocardiogram, perfusion imaging, or invasive coronary angiography) of suspected CAD (chest pain complaints, elevated risk profile, or abnormal test results). In all patients, MSCT coronary angiography was performed in addition to the standard clinical workup. Subsequent clinical management was based on the latter; MSCT findings were not included in the diagnostic/therapeutic workup.

Only patients without previous coronary bypass grafting who were in sinus rhythm and without contraindications to iodinated contrast media were included, resulting in the exclusion of 5 patients because of potential contrast allergy (n = 3) and atrial fibrillation (n = 2), respectively. Follow-up was successful in all patients. All patients gave written informed consent to the study protocol, which was approved by the local ethics committee.

A structured interview and clinical history were acquired, and the following cardiac risk factors were assessed before the MSCT examination: 1) diabetes mellitus (defined as a fasting glucose level of ≥7 mmol/l or the need for insulin or oral hypoglycemic agents) (5); 2) hypercholesterolemia (defined as a total cholesterol level ≥5 mmol/l or treatment with lipid-lowering drugs) (6); 3) hypertension (defined as blood pressure ≥140/90 mm Hg or the use of antihypertensive medication) (7); 4) obesity (body mass index ≥30 kg/m^2) (8); 5) positive family history of CAD (defined as the presence of CAD in first-degree relatives younger than 55 [male] or 65 [female] years of age) (9); and 6) smoking (defined as previous or current smoking).

MSCT data acquisition. All examinations were performed using Toshiba Multislice Aquilion systems (Toshiba Medical Systems, Tokyo, Japan). If the heart rate was ≥65 beats/min, additional oral beta-blockers (metoprolol, 50 mg, single dose, 1 h before scan) were provided if tolerated. First, a prospectively triggered coronary calcium scan was performed before MSCT angiography with identical parameters for 16- and 64-slice MSCT systems: collimation 4 × 3.0 mm, gantry rotation time 500 ms, tube voltage and tube current 120 kV and 200 mA, respectively. The temporal window was set at 75% after the R-wave for electrocardiographically triggered prospective reconstruction.

Abbreviations and Acronyms

CAD = coronary artery disease

EBCT = electron beam computed tomography

LAD = left anterior descending coronary artery

LM = left main coronary artery

MSCT = multislice computed tomography

SPECT = single-photon emission computed tomography

Sixteen-slice MSCT coronary angiography was performed according to the protocol described elsewhere (10). The following parameters were applied for 64-slice MSCT coronary angiography: collimation of 64 × 0.5 mm; tube rotation time of 400, 450, or 500 ms, depending on the heart rate; tube current 300 mA at 120 kV. Nonionic contrast material was administered in the antecubital vein with an amount of 80 to 105 ml, depending on the total scan time, and a flow rate of 5 ml/s (Iomeron 400, Bracco Altana Pharma, Konstanz, Germany). Automated detection of peak enhancement in the aortic root was used for timing of the scan. All images were acquired during an inspiratory breath hold of approximately 10 s, with simultaneous registration of the patient's electrocardiogram. With the aid of a segmental reconstruction algorithm, data of 1, 2, or 3 consecutive heartbeats were used to generate a single image.

To evaluate the presence of coronary artery plaques, reconstructions in diastole (typically 75% of the cardiac cycle) were generated with a slice thickness of 0.5 mm at an increment of 0.3 mm. If motion artefacts were present, additional reconstructions were made in different time points of the R-R interval. Axial data sets were transferred to a remote workstation (Vitrea 2, Vital Images, Plymouth, Minnesota) for postprocessing and subsequent evaluation.

MSCT data analysis. CORONARY ARTERY CALCIUM SCORE. The coronary artery calcium score was assessed with the application of dedicated software (Vitrea 2). Coronary artery calcium was identified as a dense area in the coronary artery exceeding the threshold of 130 HU. An overall Agatston score was recorded for each patient.

CORONARY PLAQUE ASSESSMENT. For the current study, all MSCT angiograms were evaluated within a time frame of 2 weeks by 2 experienced observers unaware of the clinical history of the patients, using a standard analysis (see later text). In case of disagreement, a joint reading was performed and a consensus decision was reached. Coronary arteries were divided into 17 segments according to the modified American Heart Association classification (11). Only segments with a diameter >1.5 mm (as measured on the MSCT coronary angiogram) were included. First, each segment was classified as interpretable or not. Predefined, patients were excluded from the analysis in case of: 1) an uninterpretable proximal or mid segment, or 2) more than 3 uninterpretable segments in general.

Then, the interpretable segments were evaluated for the presence of any atherosclerotic plaque using axial images and curved multiplanar reconstructions. Coronary plaques were defined as structures >1 mm^2 within and/or adjacent