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Invasive Versus Noninvasive Evaluation of Coronary Artery Disease

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OBJECTIVES We sought to compare the diagnostic information obtained from noninvasive characterization of coronary artery disease by using multidetector computed tomography (MDCT) and myocardial perfusion imaging (MPI) and to compare findings with the use of invasive coronary angiography and intravascular ultrasound (IVUS).

BACKGROUND Preliminary comparisons have suggested that abnormal myocardial perfusion studies correlate well with significant luminal stenosis on MDCT coronary angiography. However, atherosclerotic coronary lesions may be detectable with the use of MDCT even in the presence of normal myocardial perfusion

METHODS We performed MDCT, MPI, and conventional coronary angiography in 70 patients. In addition, IVUS was performed in 53 patients. Quantitative information was obtained from quantitative coronary angiography (QCA) and IVUS assessment of plaque burden and minimal luminal area.

RESULTS Of 26 patients with an abnormal MPI study, 23 (88%) showed significant stenosis on MDCT. As compared with QCA, MDCT showed a sensitivity of 96% and specificity of 67% for the detection of stenoses ≥50% diameter narrowing in these patients. Mean diameter stenosis on QCA was 76% and mean minimal lumen area in IVUS was 3.3 mm^2. On the other hand, 27 (84%) of 44 patients with normal MPI had evidence of coronary atherosclerosis on MDCT (luminal stenosis ≥50%: n = 15, luminal stenosis <50%: n = 12, sensitivity of 100% and specificity of 83% as compared with QCA). Using IVUS, we found substantial plaque burden (mean 58.9 ± 18.1% of cross-sectional area), but presence of a stenosis (minimal lumen area <4.0 mm^2) in only 14 patients (mean minimal lumen area, 5.8 ± 3.3 mm^2). Only 7 patients with normal myocardial perfusion scans demonstrated absence of coronary atherosclerosis by MDCT.

CONCLUSIONS Considerable plaque burden can be observed with MDCT even in the absence of myocardial perfusion abnormalities. This finding does not constitute a false-positive MDCT result, but rather reflects the fact that MDCT can detect atherosclerotic lesions that are not flow-limiting. (J Am Coll Cardiol Img 2008;1:190–9) © 2008 by the American College of Cardiology Foundation

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Traditionally, the evaluation and management of patients with suspected coronary artery disease (CAD) has been based on the noninvasive detection of ischemia followed by the use of invasive coronary angiography to confirm the presence of luminal stenosis. Generally, a very good correlation between the stress myocardial perfusion or echo studies and quantitative angiography is found. However, it is well established that acute coronary events usually result from voluminous atherosclerotic lesions but may not be associated with significant luminal obstruction. Intravascular ultrasound (IVUS) studies have demonstrated that even significant atherosclerosis burden may not always result in luminal obstruction and may be frequently associated with normal myocardial perfusion (1,2). The recent introduction of 64-slice multidetector computed tomography (MDCT) has allowed the opportunity to noninvasively characterize the atherosclerotic lesions and define luminal and vessel wall alterations alike. The technique has been demonstrated to have a high diagnostic accuracy as compared with invasive coronary angiography (3). It is conceivable that the majority of patients with abnormal myocardial perfusion imaging (MPI) also will show high-grade stenoses on MDCT. In addition, MDCT should allow recognition of plaque burden in patients with normal perfusion (4,5). These patients with normal perfusion may only show minimal changes on invasive coronary angiography despite definitive atherosclerotic disease. Accordingly, the purpose of the present study was to compare the diagnostic information obtained from noninvasive characterization of CAD by MDCT and MPI and to compare findings with invasive coronary angiography and IVUS.

METHODS

Patients and study protocol. The study group consisted of symptomatic patients who presented to the outpatient clinic (Leiden, the Netherlands, and Aalst, Belgium) for the evaluation of chest pain. Noninvasive imaging with the use of gated single-photon emission computed tomography (SPECT) and MDCT was performed and, on the basis of clinical presentation and/or imaging results, 70 of these patients were referred for invasive coronary angiography in combination with IVUS and enrolled in the present study. Exclusion criteria were contraindications to MDCT (6) and the presence of unstable angina, heart failure, myocardial infarction, or revascularization between the imaging procedures. Data of 15 patients have been previously reported in a study comparing MDCT and MPI (5). The study protocol was approved by the institutional ethics committee, and informed consent was obtained in all patients.

Clinical characteristics of the study population are presented in Table 1. Of the 70 patients (mean age 62 ± 11 years) included in the study, 46 (66%) were men. Diagnosis of CAD was established in 5 (7%) and suspected in the remaining 65 (93%) patients. Of the patients with known CAD, 4 had previous percutaneous coronary intervention (with stent placement in 2 patients), whereas 1 patient had previous coronary artery bypass grafting. In the latter patients, 2 bypassed (grafted) coronary vascular territories were excluded from analysis. In all patients, MPI, MDCT, and conventional coronary angiography (with quantitative coronary angiography [QCA]) were performed. In 53 patients, additional vascular imaging with IVUS was performed in a total of 109 coronary arteries. In the remaining 17 patients, IVUS imaging was not possible because of the presence of left main stenoses, severe coronary stenosis, or total occlusion (n = 10) and technical problems or time constraints during conventional coronary angiography (n = 7).

MDCT coronary angiography. We performed MDCT coronary angiography with either an Aquilion 64 (Toshiba Medical Systems, Tokyo, Japan) or a Sensation 64 (Siemens, Munich, Germany). First, a prospective coronary calcium scan was performed before MDCT angiography with a collimation 4 × 3.0 mm, gantry rotation time 500 ms, the tube voltage 120 kV, and tube current 200 mA. The temporal window was set at 75% after the R-wave for electrocardiographically triggered prospective reconstruction. For the contrast-enhanced scan, collimation was either 64 × 0.5 mm or 64 × 0.6 mm, respectively. The tube current was 300 mA, at 120 kV. Nonionic contrast material was administered in the antecubital vein with an amount of 80 to 110 ml for 64-slice MDCT, depending on the total scan time, and a flow rate of 5 ml/s (Iomeron 400, Bracco, Milan, Italy), followed by a saline flush. Subsequently, data sets were reconstructed and transferred to a remote workstation as previously described (6). Coronary calcium score was derived with the use of dedicated software. Coronary calcium was identified as a dense area in the coronary artery exceeding the

ABBREVIATIONS AND ACRONYMS

CAD = coronary artery disease
EEM = external elastic membrane
IVUS = intravascular ultrasound
MDCT = multidetector computed tomography
MLA = minimal lumen area
MPI = myocardial perfusion imaging
QCA = quantitative coronary angiography
RI = remodeling index
SPECT = single-photon emission computed tomography