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CAD-RADS for Patients with Acute Chest Pain: A Step in the Right Direction

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Acute chest pain is a common reason for visits to the emergency department. A minority of such patients have definite acute coronary syndrome and need immediate invasive work-up. However, most of these patients have possible acute coronary syndrome, are at low or intermediate risk of adverse cardiac events, and have an unelevated initial troponin level and negative or nondiagnostic results at electrocardiography. In these patients, the diagnostic evaluation is challenging because of the spectrum of underlying causes. Coronary CT angiography (CCTA) is gaining importance as an early diagnostic test in these patients, supported by contemporary guidelines on management in non-ST-segment elevation acute coronary syndrome and randomized trial results (recently reviewed by Kumar et al [1]). CCTA allows for safe exclusion of coronary artery disease (CAD) in a considerable number of patients with acute chest pain. Furthermore, CCTA can help accurately assess the presence and extent of anatomic CAD. Inclusion of CCTA in management of the low- and intermediate-risk patient cohort leads to efficient triage and reduced length of stay at the emergency department (1).

So far, emergency department studies generally involved stenosis categorization as CCTA outcome, with stenosis grade being related to the presence of acute coronary syndrome and the risk of major adverse cardiac events (MACEs). However, different studies used different stenosis degree categorizations. This complicates the comparison of results and clinical implementation (2,3). Moreover, in recent CCTA studies, nonobstructive CAD and high-risk plaques were also found to be predictors of MACEs (4,5). To standardize reporting of CCTA findings and communication with referring physicians, the Coronary Artery Disease Reporting and Data System (CAD-RADS) was established (6). Apart from standardized CCTA stenosis categorization, CAD-RADS also includes grading of non-obstructive CAD, a separate category for left main coronary artery and multivessel stenosis, and high-risk plaque

as a modifier. Specific interpretations and management suggestions are provided for patients with stable chest pain and for low-to-intermediate risk patients with acute chest pain. A recent analysis of 3840 patients with stable chest pain from the Prospective Multicenter Imaging Study for Evaluation of Chest Pain, or PROMISE, trial (4) focused on the prognostic value of CAD-RADS for MACEs during a median follow-up period of 25 months. CAD-RADS scores outperformed traditional stenosis-based categorization regarding discriminatory and prognostic value.

The well-executed study by Lee and colleagues (7) in this issue of *Radiology* is, to my knowledge, the first that analyzes the prognostic value of CAD-RADS in patients with acute chest pain. The study included 1492 low-to-intermediate risk patients presenting to the emergency department with acute chest pain. The patients underwent CCTA for clinical indications. Patients were followed up for a median of 31.5 months. During follow-up, 7% of patients ($n = 103$) developed MACEs (ie, cardiac death, nonfatal myocardial infarction, or hospitalization for unstable angina). At CCTA, 50% of patients had no coronary plaque (CAD-RADS category 0). The percentage of patients with higher CAD-RADS categories was relatively low—7% were classified as CAD-RADS category 3 (moderate stenosis), 8% were classified as CAD-RADS category 4A or 4B (severe stenosis), and 2% were classified as CAD-RADS category 5 (occlusion). There was a strong and graded increase in MACE risk according to CAD-RADS category, up to a hazard ratio of 8.5 for CAD-RADS categories 4A or 4B and 5, even after adjustment for clinical risk factors. The CAD-RADS score greatly improved risk prediction compared with clinical risk factors alone (area under the curve, 0.85 vs 0.63, respectively; $P < .01$). Interestingly, 14% of patients had high-risk plaques, and one-third of these patients had an event. This is similar to the percentage of patients classified as CAD-RADS category 4A or 4B (34.5% MACE rate). High-risk plaque was found to be an independent predictor of MACEs (hazard ratio = 3.6) independent from the CAD-RADS score.

The results by Lee et al (7) confirm in an acute chest pain cohort that high-risk plaque evaluation in CCTA has value in the prediction of MACEs, independent from assessment of stenosis degree. These results complement evidence from the Rule Out Myocardial Infarction using Computer-Assisted Tomography, or ROMICAT II, trial (5), in which high-risk plaque was studied in relation to the diagnosis of acute coronary syndrome at the time of an emergency room visit. In that study, high-risk plaque

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

See also the article by Lee et al in this issue.

was found to be a strong independent predictor for diagnosis. Although the diagnostic value of CCTA findings fell outside the focus of the current study, Lee et al (7) performed subanalysis for early events (ie, within 3 months of presentation at the emergency department). This analysis confirmed high-risk plaque as an independent predictor for early events, albeit with a slightly lower hazard ratio.

Lee and colleagues (7) compared the prognostic value of CAD-RADS categorization not only to clinical risk factors, but also to the coronary artery calcium score (CACS). Just like CCTA, CACS has been widely studied in patients with acute chest pain with a low to intermediate risk of adverse cardiac outcomes. CACS is a robust imaging marker of coronary calcification and is based on findings at low-cost, low-dose unenhanced CT. In low-to-intermediate risk patients, CACS has discriminatory value in the diagnosis of acute coronary syndrome (8). However, an analysis in the patients enrolled in the ROMICAT II trial showed that CACS did not add diagnostic value beyond CCTA-derived stenosis (3). There is debate about the role of CACS evaluation in acute chest pain, mainly focusing on the accuracy of a CACS of zero to exclude acute coronary syndrome and MACEs. Multiple studies have shown that a CACS of zero results in a very low risk of MACEs (see evidence review in Chaikriangkrai et al [9]) and makes acute coronary syndrome very unlikely (3,8), although CCTA may show particularly nonobstructive CAD (8). In the study by Lee et al (7) a high percentage of patients had no coronary calcium (61%). Of these, 15% had minimal or mild nonobstructive CAD (CAD-RADS categories 1 and 2) and 5% had moderate or severe stenosis (CAD-RADS categories 3 and 4A and 4B). The risk of MACEs was strongly related to increasing CACS categories, but risk stratification was better with the CAD-RADS score than with the CACS (area under the curve for clinical risk factors plus CAD-RADS, 0.85 vs 0.76 for clinical risk factors plus CACS; $P < .01$). However, 0% of patients with a CACS of zero developed MACEs during the 31.5-month follow-up period (including the diagnosis at the index visit). This event rate is even lower than that reported in the meta-analysis by Chaikriangkrai et al (0.5% per year) (9). In my opinion, the results of the study by Lee et al (7), in view of the sizable cohort of acute patients with a CACS of zero and the extremely low MACE rate, should make us rethink the potential worth of CACS as an efficient test to triage for subsequent CCTA, namely in those patients with a positive CACS.

An important part of CAD-RADS is the fact that a distinction is made between degrees of nonobstructive CAD and between extent and distribution of more severe CAD (CAD-RADS category 4A: 70%–99% stenosis; CAD-RADS category 4B: >50% stenosis in left main coronary artery or three-vessel obstructive [$\geq 70\%$ stenosis] disease; and CAD-RADS category 5: 100% stenosis, total occlusion). There are linked interpretations of the likelihood of acute coronary syndrome and clinical decision support for these categories. Unfortunately, because of limited power, the three highest CAD-RADS categories were combined for outcome analysis in the study by Lee et al (7), and so the value of CAD-RADS could not be explored to its full potential. The two nonobstructive CAD scores were also

combined. Studies with more patients in higher CAD-RADS categories and with longer-term follow-up are needed to evaluate in more detail the predictive power of the individual CAD-RADS categories and to compare it with traditional stenosis grading. This analysis can likely be performed according to data from one of the previous trials. Furthermore, the study by Lee et al (7) is a retrospective analysis of the prognostic value of CAD-RADS in patients with acute chest pain at low to intermediate risk, but this did not allow for evaluation of the actual impact of CAD-RADS categorization in the emergency department setting on management and diagnostic and prognostic outcomes. For this, prospective studies are eagerly anticipated.

The valuable study by Lee et al (7) gives a first glimpse, but a defining and consequential one, of the value that a standardized CCTA reporting system, including its additional CAD features, can have in patients with acute chest pain. This study contributes to the building of evidence that CAD-RADS will provide a significant contribution toward more harmonized and clear communication of CT-derived results with referring physicians. CAD-RADS helps to standardize quality of care and, moreover, may improve the outcome in patients with acute chest pain across emergency departments. Although it may still be, as to be expected in such a study, a preliminary expectation, in my opinion, it is a big step in the right direction.

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