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EDITORIAL COMMENT

The Challenge of Effectively Reporting Coronary Angiography Results From Computed Tomography*

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Noninvasive coronary angiography by computed tomography is poised to become the cornerstone for the evaluation of coronary heart disease. Data from large clinical studies are accumulating which demonstrate the superiority of an anatomic assessment over the traditional functional evaluation for the outcome of patients with suspected coronary heart disease (1,2). Recognizing the consistency and strength of the available evidence, the National Institute for Clinical Excellence (NICE) in the United Kingdom now recommends computed tomography angiography (CTA) as the first diagnostic test in patients with chest pain of recent onset (3). Other practice guidelines are likely to adopt a similar approach.

Reporting computed tomography angiography (CTA) findings in a manner that helps clinicians to establish a diagnosis and to appropriately guide patient management is critical for the success of CTA in clinical practice. Ideally, coronary CTA reporting should be standardized across laboratories and should clearly identify information relevant for the diagnosis and management of patients with suspected coronary heart disease. In general, the assessment of such patients must focus on: 1) establishing or refuting the diagnosis of coronary heart disease; and 2) identifying the need for further testing or interventions to improve patient outcome beyond standard measures. Because *invasive* coronary angiography has been the standard for the diagnosis of coronary heart disease for many decades, CTA reporting adopted the traditional model from the cardiac catheterization laboratory, which focuses on coronary arterial lumen narrowing and the number of involved vessels. This practice is based on clinical trial results demonstrating that risk of adverse events increases with the coronary atherosclerotic disease burden, and that revascularization improves the outcome of patients with extensive disease. Current practice guidelines identify high-risk coronary anatomy (left main, 3-vessel, and 2-vessel coronary artery disease involving the proximal left anterior descending coronary artery [LAD]) as the only Class I indication for revascularization with the intent of improving survival in patients with stable coronary heart disease (4). Revascularization for relief of angina, on the other hand, should occur only after medical therapy has failed, as coronary revascularization is not associated with improved survival or reduced risk of myocardial infarction in the absence of high-risk anatomy (4).

Beyond identifying patients in need of coronary artery revascularization, patients benefit from varying intensity of medical therapy according to their risk profile. For example, a patient with mild nonobstructive coronary heart disease may benefit from low-dose aspirin and low-dose statin, whereas dual antiplatelet therapy or an aspirin combination with systemic anticoagulation and intensive lipid-lowering therapy may be appropriate in a patient with multivessel obstructive disease.

A particular challenge for selecting the most appropriate information for CTA reporting of coronary angiography derives from the fact that there is much more information available by CTA than by standard invasive angiography. The ability to directly visualize atherosclerotic disease, its tissue characteristics, remodeling patterns, and nowadays also information on coronary flow patterns and

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inflammatory activity provides immense opportunity to further improve our ability to risk stratify and manage patients—approaching the goal of precision medicine. At the same time, we currently lack conclusive outcome data for most of these metrics, which increases the dilemma for the reporting physician as to which information to transmit and which to withhold in order to avoid confusion among referring practitioners. Given such current uncertainty, it appears prudent to focus our information from CTA on present knowledge and practice, that is, the coronary anatomy, with the intent to build upon our algorithm with the availability of conclusive data.

To improve standardization among CTA reporting, and following similar approaches for radiology reporting in other fields (e.g., Breast Imaging Reporting and Data System [BI-RADS], Prostate Imaging Reporting and Data System [PI-RADS]), Cury et al. (5) proposed a coronary artery disease reporting and data system, CAD-RADS (Coronary Artery Disease–Reporting and Data System), which lists management recommendations for each category. Although improved standardization of CTA reporting is desirable in many regards, including the facilitation of large data analysis, a new reporting system should: 1) be straightforward and practical; 2) respond to current demands of clinical practice; and 3) offer a clear advantage over the current model if it deviates from current terminology. Chandrashekhar et al. (6) raised several important questions about the usefulness and applicability of CAD-RADS in its current form, particularly, in regards to the proposed hierarchy of disease severity and implications for management. CAD-RADS categorizes coronary artery disease severity largely by the extent of lumen stenosis, i.e., 0% to 100%, but does not adequately consider the *extent* of disease in this hierarchy nor its implications for management. For example, the highest category is given for total coronary artery occlusion (CAD-RADS 5), but while a total occlusion may pose a challenge to revascularization attempts, it has no independent role for determining the need for revascularization (with the intent of improved patient survival). A chronically occluded small right coronary artery without LAD or left circumflex disease is a very different clinical entity than 3-vessel coronary artery disease including an occluded LAD. Both scenarios, however, would be categorized as CAD-RADS 5.

On the other hand, no mention is made of stenosis in the proximal LAD, which, in the context of 2-vessel disease, is considered part of the high-risk coronary heart disease spectrum warranting consideration for revascularization with the intent of improved patient survival (4).

Most importantly, CAD-RADS misses the opportunity to adequately recognize the emergence of nonobstructive coronary artery disease as an important entity on the disease spectrum of coronary heart disease (7). The ability to noninvasively detect nonobstructive coronary artery disease must be considered one of the major advances in the prevention of coronary heart disease facilitated by CTA. The PROMISE trial revealed that two-thirds of myocardial infarctions and deaths occurred in patients with normal stress test results (8). Responding to the recognition of nonobstructive coronary artery disease by implementing preventative treatment has been shown to reduce the risk of myocardial infarction by 30% (1,2), prompting the change in the NICE guidelines. Although CAD-RADS lists 2 categories for mild disease, it does not differentiate whether the disease is limited or extensive. For example, a single 25% stenosis carries different prognostic information than 3 vessels with 45% lesions in each (7). In times of increasing awareness of our resource utilization and unnecessary patient injury, tailoring the intensity of medical therapy according to the patient's risk profile is critical.

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In this issue of *iJACC,* Xie et al. (9) report data to validate the CAD-RADS system using an analysis of the CONFIRM (COronary CT Angiography EvaluatioN For Clinical Outcomes: An InteRnational Multicenter) registry. Their results suggest that retrospective disease categorization using CAD-RADS at baseline allows risk stratification for patient outcome. However, their data also demonstrate that CAD-RADS does not offer an advantage over the traditional CAD reporting in this regard (their Figure 3, area under the curve 0.745 vs. 0.756). Interestingly, the authors' data suggest that CAD-RADS 5 is associated with worst patient outcome, though not statistically different from CAD-RADS 4. This finding is likely related to the greater risk profile among patients with CAD-RADS 5 compared to other groups as shown by the authors' data. In addition, though not apparent from the authors' report, it is likely that total artery occlusion is a marker for greater coronary atherosclerotic disease burden, which would largely explain this association. Insights into the underlying mechanisms that lead to adverse patient outcome will help focus on the most meaningful predictors.

Furthermore, the authors (9) provide data on the utilization of invasive coronary angiography after CTA, revealing that patients with moderate stenosis

(defined as 50% to 69% by CAD-RADS) undergo cardiac catheterization in almost 50% of cases within 90 days of CTA. They do not show the same analysis using traditional coronary artery disease reporting (which likely would have resulted in similar results).

The authors raise the important issue of resource utilization after CTA. Because CTA is more sensitive than stress testing for detecting coronary artery disease, referrals for cardiac catheterization occur more frequently after CTA, sparking criticism by some (10). The problem, however, does not lie with CTA—it lies with our liberal referral practice for cardiac catheterization. Current practice guidelines list only 2 indications for invasive angiography in the context of stable angina and CTA results (4): 1) high-risk coronary artery disease defined as multivessel disease (stenoses ≥70%) or left main disease; or 2) intractable angina not responding to adequate medical therapy. As shown by Xie et al. (10), these recommendations are often not followed in clinical practice. The CAD-RADS system in its current form, however, is unlikely to change this pattern because it still assumes CTA to be merely a gatekeeper for cardiac catheterization. Indeed, CAD-RADS lists invasive angiography among the cardiac investigations to consider in patients with single-vessel obstructive CAD, and, as such, practitioners are encouraged to look for confirmation of CTA results instead of responding with the adequate management decisions.

There is opportunity to revise our current reporting model to better reflect existing and emerging data. Among these, distinct recognition of high-risk coronary anatomy (left main, 3-vessel disease, and 2-vessel disease involving the proximal LAD) for determining the need for revascularization with intent to improve patient survival should be differentiated from disease that can be safely managed medically. Current practice guideline recommendations should be reinforced, and, in the absence of high-risk features, patients should only be referred for coronary artery revascularization with the intent to relieve stable angina only if a trial of medical therapy is unsuccessful. The latter is an uncommon scenario if medical therapy is adequately provided as recently confirmed by the ORBITA trial (11). Lastly, recognizing the importance and extent of nonobstructive coronary artery disease for tailoring the intensity of medical therapy is an important evolving concept that should be incorporated into our assessment of patients with suspected coronary heart disease.

CTA is finally at the doorstep to become the central modality for both the diagnosis and management of patients with suspected coronary heart disease. Large clinical trials are in preparation that will provide conclusive data on the comparative effectiveness of CTA and invasive angiography for the evaluation and management of patients with angina pectoris, which may finally allow us to move beyond cardiac catheterization as the diagnostic standard for coronary artery disease. An effective model of reporting coronary CTA that considers these developments will facilitate the CTA's transitioning towards the cornerstone of coronary artery imaging.

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