CAD-RADS: a new era in coronary CTA reporting

By Dr. S. Ramanathan

Coronary artery disease (CAD) is one of the leading causes of death and of disability-adjusted life years (DALY) lost. Approximately 15.5 million persons ≥20 years of age in the USA have CAD according to the 2016 Heart Disease and Stroke Statistics update of the American Heart Association (AHA) [1]. It is well established that CAD has a long asymptomatic latent period and mortality and morbidity can be decreased by early detection and targeted preventive therapy. Various imaging modalities for evaluating patients at increased risk for CAD include Coronary CT angiography (Coronary CTA), cardiac MRI, cardiac perfusion scintigraphy, echocardiography, and positron emission tomography (PET). Among these non-invasive imaging modalities, Coronary CTA has gained more acceptance and popularity due to its high diagnostic accuracy in the noninvasive estimation of coronary arterial stenosis similar to invasive coronary angiography (ICA). A new standardized reporting system CAD-RADS (Coronary Artery Disease Reporting and Data System) was introduced in 2016 to develop a uniform reporting pattern to enable more effective communication of the results to the referring physicians. This review aims to explain the essential features of individual CADRADS categories, their clinical implications, potential benefits and pitfalls.

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CURRENT STATUS OF CORONARY CTA

Coronary CTA has now emerged as an effective non-invasive diagnostic test to evaluate coronary arteries in patients with low to intermediate likelihood of obstructive CAD in outpatient as well as emergency settings. Due to rapid advancements in CT technology such as multislice CT (from 16 slice to 64 slice and now reaching 320 slices), dual energy CT and radiation dose reduction algorithms, moderate to high diagnostic accuracy has been achieved. The reported sensitivity and specificity for 64-slice CT ranges from 85 to 99% and 86 to 96% respectively. Furthermore, with the advent of 320 slice Coronary CTA, the diagnostic accuracy has improved to 95% with 100% negative predictive value for detection of >50% coronary stenosis [2,3].

The main clinical benefit of coronary CTA is derived from its high sensitivity and negative predictive value. This helps in confidently ruling out significant CAD thereby avoiding further diagnostic tests and invasive procedures. The positive predictive value of coronary CTA is lower, and especially intermediate lesions may be overestimated regarding their relevance [4].

Based on these various randonized controlled trials, the American Heart Association/Society of Cardiovascular Computed Tomography (AHA/SCCT) and the British National Institute for Health and Care Excellence (NICE) guidelines recommend Coronary CTA as an appropriate test to rule out obstructive CAD in low-to intermediate risk patients with stable or acute chest pain [5,4]

WHY CAD-RADS?

SCCT guidelines published in 2009 and the last update in 2014 stressed the reporting of qualitative and quantitative coronary arterial stenosis, as the main purpose of Coronary CTA is to rule out significant CAD. Due to recent technological advancements the spatial and temporal resolution of current scanners has since improved drastically. This in turn facilitated development of various new scanning and post-processing techniques like computed tomography-derived fractional flow reserve (CT-FFR) and perfusion imaging. Hence Coronary CTA is no longer just an anatomic imaging modality but is being increasingly used for characterizing the plaque morphology to predict current and future cardiac events

and also for functional imaging [6,7]. As the complexity of Coronary CTA has increased enormously, standardization becomes a necessity to maximize the clinical impact. Various professional societies have issued guidelines and expert consensus documents on the performance, acquisition, necessary training, reporting, indications and radiation dose. The recent addition to this is the standardized reporting system CAD-RADS.

The presence of common reporting terminologies and categories with streamlined management recommendations helps in simplifying the reporting structure and makes it more understandable for the referring physicians. This is based on the success of similar models in breast (BIRADS), liver (LIRADS), and prostate imaging (PIRADS). It creates consistency in the conclusions of the report which in turn guides the referring physicians to take clinical decisions. Apart from decreasing the variability among the reporting radiologists, CAD-RADS also facilitates education, research, peer review and quality assurance leading to improved patient care.

CAD-RADS categories

A new standardized reporting system proposed by the Society for Cardiovascular Computed Tomography (SCCT), the American College of Radiology (ACR), and the North American Society for Cardiovascular Imaging (NASCI), and was endorsed by the American College of Cardiology (ACC) and published in JACC in 2016 [8-10].

This recommendation is intended for two groups of patients:
(1) Patients presenting with stable chest pain.
(2) Patients presenting with acute chest pain, negative first troponin, negative or non-diagnostic electrocardiogram, and low to intermediate risk.

CAD-RADS aims to classify CTA based results on the severity of stenosis and to link this data to clinical patient management. The indication for coronary CTA, scan protocols and performance standards remains the same. Interpretation, training standards and quantification of coronary arterial stenosis is based on the 2014 SCCT reporting guidelines in both acute and non-acute settings [7].

CAD-RADS category	Degree of stenosis	Interpretation	
		Acute chest pain	Stable chest pain
0	0%	ACS highly unlikely	Absent CAD
1	1-24%	ACS highly unlikely	Minimal non-obstructive CAD
2	25-49%	ACS unlikely	Mild non-obstructive CAD
3	50-69%	ACS possible	Moderate stenosis
4	70-99%	ACS likely	Severe stenosis
5	100%	ACS very likely	Total occlusion

Table 1. Summary of CAD-RADS categories and their interpretation

"... The presence of common reporting terminologies and categories with streamlined management recommendations helps in simplifying the reporting structure and makes it more understandable for the referring physicians..."

There are six CAD-RADS categories, based on degree of luminal diameter stenosis. This is adapted from SCCT 2014 recommendations. They range from CAD-RADS 0 (absence of plaques and stenosis) to CAD-RADS 5 (presence of at least one total occlusion) in both acute and non-acute settings. It is based on the most severe coronary finding. Apart from these six categories, an additional category N is added which represents non-diagnostic study. Furthermore category 4 is subdivided in to 4A - single or two vessel 70-99% stenosis and 4B-Left main >50% or 3- vessel obstructive (>70%) disease. This classification is applicable only for vessels greater than 1.5 mm in diameter. Detailed discussion on the management strategies in individual categories is beyond the scope of this mini-review but is freely available in the source publication [8-10]

MODIFIERS

In additon to the main categories, there is an option to add modifiers at the end of each category (separated by /) to provide additional relevant information. Four modifiers are available: N (non-diagnostic), S (stent), G (graft) and V (vulnerability). If more than one modifier is applicable, they should be separated by the slash symbol "/" and written in the same order as above.

BENEFITS OF CAD-RADS [11]

1. Consistency - The most important utility of any standardized reporting system is improved consistency. This helps in providing a uniform report consistently with the usage of common language and accepted terminologieOne recent study shows excellent inter-observer agreement in assigning CAD-RADS categories, including the degree of stenosis and modifiers leading to a more consistent final report [12]

2. Communication - In the long run, using a consistent reporting template improves communication to the referring physicians as they get used what to expect in the report

3. Clinical management - Including the clinical pathway in the imaging report is the most innovative aspect of CAD-RADS. It helps in choosing

the best investigation and further treatment options based on the categories thereby somewhat simplifying the clinical management protocol

4. Research - Uniform reporting helps in the future data collection in a more organized manner leading to more effective research and education

PITFALLS OF CAD-RADS [13,11]

1. Misinterpretation - This is an inherent pitfall of coronary CTA rather than CAD-RADS itself and can present in the form of under- or over-estimation of the degree of stenosis and in the risk assessment of high risk plaque features, both leading to assign wrong categories

2. Misclassification - Some components of CAD-RADS such as category N, 4A, 4B, grafts and stents can be a potential source of error in the initial period due to overlap and some similarities. These should improve with continuous usage and training

3. **Missing components** - Although CAD-RADS system is extensive, few components like location and extent of disease, coronary anomalies and extra cardiac findings are not included. With accumulation of more data and knowledge, these might get a place in the future versions

4. **Misguidance** - Although considered generally as a benefit, recommendations regarding further investigations and treatment options included in the CAD-RADS can be a potential pitfall as well. In clinical practice, there could be many other factors apart from the stenosis which can influence the management along the individual physician judgement. Sometimes these can be different from the CAD-RADS recommendation and can thus be a source of conflict

FUTURE OF CAD-RADS

CAD-RADS is just the first step in the attempt to standardize enormously the increasing numbers of coronary CTA examinations. Many of the pitfalls described above can be resolved in the future versions as we gain more experience by using this system on a daily basis. There could be additional categories and subcategories to include the missing components. By having more healthy discussions with clinicians, we can agree to minimal management recommendations which will give the cardiologists enough space to make individualized patient decisions. Of course more training and stimulating the residents, fellows and young radiologists to strictly use the system is essential for its success and future improvements

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