It's in the Field of View!

Coronary Artery Analysis on Chest Computed Tomographic Angiography

Harvey S. Hecht, Jagat Narula, Jonathon Leipsic

Several questions of great importance to the cardiovascular community loom large in chest CT imaging:

1. **Is the imager responsible for reporting all relevant cardiovascular findings in the field of view?**
2. **If imaging of the requested organs (aorta and pulmonary arteries) on computed tomographic angiography is enhanced by simple techniques that enable analysis of the coronary arteries, should the acquisition standard of care be changed to permit coronary analysis and reporting?**

Coronary Artery Calcium Analysis on Noncontrast Chest CT Scans

The Society of Cardiovascular Computed Tomography and Society of Thoracic Radiology have answered the first question in the 2016 SCCT/STR Guidelines for Coronary Artery Calcium Scoring of noncontrast noncardiac chest CT scans.[1] Because Coronary Artery Calcium Scoring analysis is always feasible and the information provides robust prediction of cardiovascular events in asymptomatic patients, the guideline states that Coronary Artery Calcium Scoring by quantitative or semiquantitative analysis should be part of every noncontract chest CT analysis and report, whether gated or nongated, even though it has not been requested by the referring physician.

Coronary Artery Analysis on Contrast Chest CT Scans

The second question, which has not been addressed by any guideline, relates to coronary artery analysis and reporting on contrast CT scans ordered for the acute scenarios of aortic dissection (AD) and pulmonary embolus (PE) and for the chronic surveillance of thoracic aortic aneurysms, both before and after repair. This should be differentiated from the triple rule out in ED chest pain patients with clinical presentations consistent with coronary artery disease (CAD) in which AD and PE are also of concern. In this ED setting, in 1555 patients, 15.5% had >50% coronary diameter stenosis, 1.1% had PE and 0.4% had AD.[2] In a second series of 1192 patients, significant CAD was found in 11.7%, PE in 2.3%, and AD in 0.3%.[3]

As with all imaging paradigm changes, technical feasibility and a favorable benefit to risk ratio are essential.

Technical Issues

Accurate evaluation of the coronary arteries requires a motion minimalized milieu as provided by EKG synchronization or very rapid acquisitions enabled through the use of high helical pitch. Some centers routinely use ECG synchronization for the evaluation of acute aortic syndromes to differentiate dissection flaps from motion artifacts (Online Figure I). Similar improvements in image quality are noted in PE studies, particularly for distal vessels. Opacification of both the pulmonary and coronary arteries can be accomplished by injecting 75 mL contrast at 4.5 mL/s, followed by a mixture of 25 mL contrast and 25 mL normal saline at 3 mL/s, followed by a 25 mL saline bolus, with bolus timing in the descending aorta. To minimize radiation, gating is performed prospectively using a single phase determined by the patient's heart rate. The effective radiation dose is likely to be similar or less than nongated helical acquisitions. These studies are typically performed without the administration of β-blockade or nitroglycerine which may limit the accurate stenosis determination in more distal coronary segments, but atherosclerosis detection and proximal segment stenosis evaluation are highly feasible. The percentage of evaluable studies obtained in this manner has not been reported. However, the 75% phase for HR ≤65 bpm and the 40% phase for HR >65 bpm are routinely used in centers dedicated to minimizing radiation through single phase prospectively acquired studies.

Benefits

The benefits of coronary computed tomographic angiography (CTA) are well documented. It is the most robust predictor of cardiovascular events in both the asymptomatic and symptomatic populations and is associated with better accuracy and outcomes compared with functional testing.[4–6] In the absence of AD or PE, the relationship of presenting symptoms to coronary findings may be unclear and may be addressed by appropriate functional imaging confirmation.

Aortic Dissection

CTA to rule out AD is used for the clinical scenarios of chest pain/back pain and SOB but is infrequently positive. Dissection is primarily an atherosclerotic disease[7] and coronary artery disease and stenosis is a likely suspect in those without acute aortic syndrome. Not interrogating the image data for the presence of CAD is a missed opportunity in these patients that can

From the Icahn School of Medicine at Mount Sinai, New York (H.S.H., J.N.); and Department of Medicine and Radiology, University of British Columbia, Vancouver, Canada (J.L.).

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Correspondence to Harvey S. Hecht, MD, FACC, FSCCT, Mount Sinai Saint Luke's Hospital, 1111 Amsterdam Ave, New York, NY 10025. E-mail harvey.hecht@mountsinai.org

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help inform not only the acute diagnosis but also overall cardiovascular risk (Online Figure II). Moreover, if dissection is present and surgical repair is indicated, knowledge of the coronary anatomy is essential to decide on the concomitant need for coronary artery bypass grafting (Figure; Online Figure III). Since invasive coronary angiography is contraindicated in this setting, the high diagnostic accuracy of coronary CTA provides an acceptable alternative. Thus, irrespective of the dissection results, coronary anatomy delineation is essential.

Pulmonary Embolus

As with AD, the very low positivity rate (12%)[8] of pulmonary CTA leaves the vast majority of patients without an explanation for their acute symptoms. Because PE may occur in patients younger than the AD and CAD populations, an age cutoff (>45 years for men, >55 years for women) may be reasonable for coronary artery evaluation. However, irrespective of age, gated imaging will enhance the quality of the study by minimizing motion artifact. Optimal timing for opacification of both the coronary and pulmonary vasculature is easily achieved by appropriate protocols.

Aortic Aneurysm Surveillance Before and After Repair

As noted above, CAD frequently accompanies atherosclerotic aortic aneurysm,[7] and is readily evaluated. The critical coronary information is in the field of view of all gated studies and may strongly influence patient management, particularly in those with previously undiagnosed CAD, as well as in those with critical coronary lesions (left main coronary stenosis, severe triple-vessel disease) that may warrant intervention. Moreover, the improved gated aortic measurements may facilitate more accurate tracking of changes in aortic size. The same arguments hold for postrepair evaluations, with the added benefit of assessing the frequently reimplanted coronary arteries and for tracking the progression of CAD.

Risks and Barriers

Risks

Coronary artery analysis involves no additional medical risks; contrast volume is unchanged and radiation may decrease or remain unchanged, depending on the protocol and scanner. Of significant concern, however, is the possibility of increased subsequent invasive coronary angiography and possible revascularization[5] following the reporting of abnormal coronary results, which must be avoided by the same appropriate decision making that should follow dedicated coronary CTA studies.

Barriers

The obstacles to implementation of this paradigm are numerous.

Radiologist

Most importantly, because coronary analysis may be complex, the interpreting physician will likely spend more time evaluating the coronary arteries than the structures for which the scan was ordered. The lack of additional reimbursement or relative value units is a powerful disincentive. The solutions are increased reimbursement and relative value units, or increased credit within the institution or practice for the additional time expenditure.

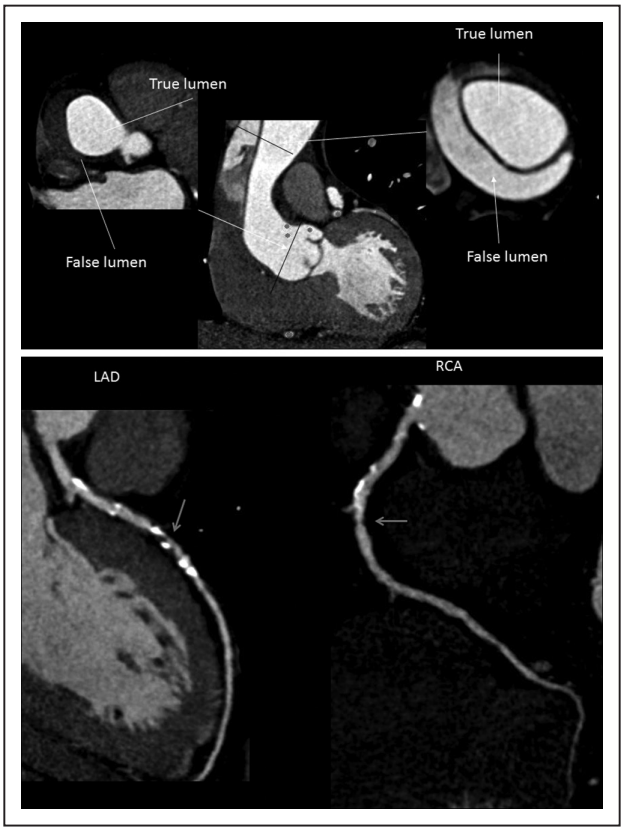

Figure. Stanford type A aortic dissection and double-vessel coronary artery disease in a 78-year-old male with right-sided neck pain and back pain. Computed tomographic angiography (CTA) was ordered to rule out aortic dissection. **Top**, Dissection is present from the aortic root through the ascending aorta, and extended to the innominate and right carotid (not shown). **Bottom**, Severe stenoses of the proximal/mid-left anterior descending (LAD) and mid-right coronary artery (RCA) are present (arrows). The patient underwent repair of the aortic dissection and bypass grafts to the LAD and RCA, without having undergone invasive coronary angiography.

AD and PE scans require immediate reporting. Therefore, 24/7 coverage by radiologists trained in coronary CTA is essential because a critical coronary stenosis cannot wait until the next day to be reported on scans performed in the middle of the night. The vast majority of radiologists do not have the requisite training for accurate coronary interpretation and providing adequate coverage is problematic. Mandatory coronary training for chest radiologists may help in the future, and CTA trained cardiologists may assist, but for the moment there is no adequate solution. Nonacute aortic aneurysm patients are not an issue; coronary evaluation can be electively performed by trained physicians.

Sixty-four or more slice scanners are required for adequate coronary analysis. While widely available, they may not be available everywhere, in which case coronary analysis should not be attempted.

Although these problems are daunting, patient benefit must be the overwhelming concern. Despite the absence of studies documenting the accuracy of coronary analysis in this setting, and improved outcomes in patients with coronary artery reporting on contrast chest CT examinations, or from improved quality of gated studies for dissection and PE, the

benefits in the absence of any risk as described above provide a compelling argument for implementation.

Referring Physician

As with CAC reporting on all noncontrast chest CT scans, the referring physician will be confronted with results that were not requested, may not be fully understood, nor be equipped to implement management changes based on the results. Cardiology evaluations should provide the solution, and judicious actions will be necessary to avoid unnecessary further testing and treatment.

Conclusions

In the midst of the cardiovascular disease epidemic, providing critical coronary artery information from chest CTA performed for evaluation of AD, aortic aneurysm, and PE without additional risk or cost, in combination with improving the quality of the CTA, should become the standard of care. The barriers of insufficient number of trained physicians for image analysis, requirement for 24/7 interpretation, inadequate compensation, and possible inappropriate use of the coronary test results must be resolved by the radiology and medical communities.

Disclosures

None.

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