Computed Tomography Coronary Angiography as an Anatomic Basis for Risk Stratification

Déjà Vu or Something New?*

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More than 2 decades ago, the initial clinical trials were published (1,2) addressing whether the extent of obstructive coronary artery disease (CAD) by invasive coronary angiography could predict subsequent patient outcome and in whom coronary revascularization would be most beneficial. Since that time, noninvasive techniques such as stress echocardiography and myocardial perfusion imaging (MPI) have largely supplanted an initial angiographic assessment in most patients. The basis for this fundamental shift from anatomy to physiology stems from a large foundation of clinical data demonstrating that inducible ischemia, in conjunction with left ventricular function, is a better barometer of risk compared to an anatomic measure (3,4) and one that can more accurately direct therapeutic decisions and thereby affect patient care.

Recently, there has been renewed interest in revisiting imaging of the coronary anatomy, but this time noninvasively using computed tomography. Computed tomography angiography (CTA) has developed at an extraordinary technical pace, with current scanners providing rapid patient throughput within a short 10- to 15-s breath hold. Improvements in temporal and spatial resolution, accompanied by sophisticated software packages for processing extensive image files, have resulted in breathtaking 3-dimensional depictions of the heart and coronary arteries. Studies directly comparing CTA to traditional angiography have yielded favorable results, barring exceptions due to image distortion from motion artifacts and/or extensive calcification, which limits visualization of the arterial lumen (5). Although stenosis severity is generally overestimated by CTA (or underestimated by invasive angiography, depending on your vantage point), the negative predictive accuracy of CTA for excluding significant CAD is reported to be >98% (5).

Despite these advances, CTA is still looking for its “niche” in clinical practice. This is not unexpected, as every imaging technique generally undergoes multiple iterations of validation before ultimately defining its role in clinical decision-making.

The Present Study

The study by Min et al. (6) in this issue of the Journal is one of 2 recent papers addressing the prognostic value of multidetector CTA (6,7). This is a large registry study that included a potpourri of patients, ranging from those who were asymptomatic (38%) to those having typical anginal symptoms (2%). The pretest likelihood of CAD was based on standard criteria, with most (50%) falling into the intermediate range. Computed tomography angiography was performed using a 16-slice system with images visually assessed to estimate coronary atherosclerotic plaque severity. Multiple phases were used to identify images exhibiting the least cardiac motion. The coronary artery tree was scored on the basis of a modified American Heart Association classification, with unevaluable segments scored similarly to the most proximal interpretable segment. The Duke prognostic CAD index was also applied to the angiographic results (8). The primary end point was all-cause mortality based on the Social Security Death Index.

The salient results from this trial are that a normal CTA predicts a very low mortality rate of only 0.3% at 15.3 months of follow-up as compared with the overall mortality of 3.5%. The presence, extent, and severity of CAD were independent predictors of all-cause mortality, as was the presence of left main stenosis. The Duke Prognostic Index was also a significant predictor of subsequent mortality.

The findings from this study are not dissimilar from those previously reported, with invasive coronary angiography with the worst outcome in patients who had triple-vessel and/or left main stenosis (1,2). Because CTA correlates reasonably well with stenosis severity by invasive angiography, these findings are not unexpected (5).

This study has several important limitations. Because it is a single-center retrospective registry, the results may not be applicable to general clinical practice. Also, although the authors have shown a relationship between CTA results and all-cause mortality, it remains to be seen whether CTA is as predictive of cardiac death and nonfatal myocardial infarction. Finally, little is known of treatment in these patients, where 30% had moderate to severe triple-vessel CAD by CTA and 10% had significant left main stenosis. Treatment was left to the discretion of practicing physicians, and it is
anticipated that many patients underwent coronary revascularization. All-cause mortality may not be reflective of cardiac events in high-risk groups who are successfully revascularized. Conversely, of the 39 patients who died, information regarding procedurally related deaths is available on only 10. Such information is critical to the proper interpretation of the study results.

The Challenges Ahead

Despite these limitations, the authors are to be commended for an important initial step in assessing risk with this relatively new imaging modality. There are, however, many questions that remain unanswered. First and foremost, how will CTA integrate with other, more formally studied techniques used in risk stratification? For example, it is well known that a coronary artery calcium score (CACS) of 0, even in symptomatic patients, will rarely (~1%) be associated with significant CAD (9). In support of this, a CACS of 0 also predicts an exceedingly low (<0.4%) annual risk for any subsequent cardiac event, let alone death, and is much simpler to perform than CTA, with less radiation exposure and no need for iodinated contrast (10,11). It is unfortunate that the authors did not perform a CACS as part of their CTA procedure. This would have provided a unique opportunity to compare both techniques in the same patients.

Stress MPI is currently the most widely utilized technique for assessing risk, with several decades of clinical trials spanning the entire spectrum of CAD (12,13). Patients at intermediate clinical risk have a reported annualized 0.6% death and reinfarction rate with a normal perfusion study, versus a 6% event rate when the scan is moderately to severely abnormal (12). Stress MPI has consistently been shown superior to coronary angiographic variables for predicting outcome and across many patient subsets (12,13). Computed tomography angiography has not been studied in relation to perfusion results for assessing prognosis, but recent data (11) suggest that a normal perfusion study predicts a very low short-term (<3 years) risk for a subsequent cardiac event, irrespective of CACS severity. Although a CACS cannot be directly equated to CTA findings, the former is a reflection of CAD extent and severity (9). Unless other variables are derived from CTA beyond those currently obtained with invasive angiography, it is unlikely that CTA anatomic data will further enhance risk stratification if the perfusion results are known. A clear opportunity for CTA might be identification of vulnerable plaque through quantification of plaque volume and its relative composition.

An additional challenge for CTA will be to demonstrate its utility in guiding patient management decisions. Stress MPI with selective coronary angiography in patients who demonstrate ischemia is a more cost-effective strategy than routine coronary angiography (14). The reason is that an ischemia-guided approach appropriately limits angiography and revascularization to the patient group at highest risk. Recent data (15,16) indicate that only 50% of patients (and one-third of arteries) with obstructive CAD by CTA will have inducible ischemia by perfusion imaging. A CTA assessment alone will likely result in additional interventional procedures at a time when a "stenosis-only" based treatment approach continues to be shown suboptimal and costly (17–19).

The future of CTA will be decided by its incremental value within the current imaging armamentarium. It may well be that selectively combining CTA with function assessments of ischemia will further streamline patient care and improve outcomes. These answers will become apparent only through prospective multicenter clinical trials. With CTA, are we revisiting the past with a novel noninvasive twist, or will this technique offer something new? I believe the latter to be true.

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REFERENCES


