

## Coronary CT Angiography: An Established, Not Emerging, Basis of Diagnosis and Risk Stratification

Leslee J. Shaw, PhD,\* Jagat Narula, MD, PhD†

In this issue of *iJACC*, 2 papers are published on risk stratification with coronary computed tomographic angiography (CTA) in the evaluation of post-coronary artery bypass surgery (CABG) patients (1) and in the evaluation of acute chest pain in the emergency department (2). The development of high quality evidence with CTA is now consistent with comparative evidence with more conventional diagnostic imaging modalities. Amazingly, this body of evidence has amassed over a very short period of time by the CTA community as a response to queries for high quality data to guide clinical decision making. A review of the published evidence reveals several hundred papers on the prognostic accuracy of CTA with most reported in the past 3 to 4 years.

The rapidity of development for CTA evidence is hard to imagine when other imaging techniques required decades to accumulate a body of evidence. Just a few short years ago, it was not uncommon to see CTA reports in 100 or fewer patients (3). Current reports frequently include multicenter registries reporting thousands of patients including data from the CONFIRM (COronary CT Angiography EvaluationN For Clinical Outcomes: An InteRnational Multicenter) registry including more than 20,000 patients (4). This is a substantial accomplishment on the part of clinical investigators who have dedicated research efforts toward providing clinically valuable information.

Not only has the computed tomography community put forth an astounding number of high quality diagnostic trials and prognostic registries but they have taken a leadership role in develop-

ing and validating strategies for reduction in radiation dose that may be uniformly applied. It is now routinely possible for a CTA examination to be performed in <3 mSv. These technological developments and continuous quality initiatives have focused on reductions in effective doses with CTA while maintaining image quality in order to provide enhanced patient safety (5,6).

The evidence clearly has accrued that CTA is an established imaging modality with proven abilities to diagnose and risk stratify significant and severe obstructive coronary artery disease with unfolding evidence in the field of nonobstructive atherosclerosis (7–11). The rapid development of this evidence base will provide a challenge for busy clinicians and readers of this journal to stay current with the coronary CTA evidence. Recent and updated meta-analysis (12), appropriate use criteria (13), and clinical practice guidelines will be helpful to synthesize this evidence base for the cardiovascular community.

Although ongoing trials are underway to compare CTA with functional stress testing, more work is required to understand the role of noninvasive versus invasive anatomic imaging to guide medical and surgical management. Perhaps the most important contribution to the literature will be the application of CTA as a gatekeeper to invasive coronary angiography in order to reduce the normal coronary angiography rate, promote cost efficiency, and reduce the rate of ad hoc percutaneous coronary intervention. This latter trial is currently under development (CONSERVE [COmputed Tomographic ANgiography for SElective Cardiac Catheterization: Relation to CardioVascular Outcomes, Cost Effectiveness and Quality of Life] trial) and as an optimal venue for CTA to showcase its strength in diagnosing the extent and severity of coronary

From the \*Program in Cardiovascular Outcomes Research and Epidemiology, Emory University, Atlanta, Georgia; and the †Zena and Michael A. Wiener Cardiovascular Institute, Mount Sinai School of Medicine, New York, New York.

disease and, importantly, does not eliminate the need for selective, complementary information on functional ischemia.

This issue of *JACC* highlights the achievements of CTA with reports such as those from Chow et al. (1) and Schlett et al. (2), their respective Editorial Comments by O'Gara and

Blankstein (14) and Schoenhagen et al. (15) and a State-of-the-Art review by Voros et al. (16). By all standards, CTA is now a mature diagnostic strategy and can be referred to as an established diagnostic imaging modality whose wealth of evidence can provide an effective means to safely guide clinical decision making.

## REFERENCES

1. Chow BJW, Ahmed O, Small G, et al. Prognostic value of CT angiography in coronary bypass patients. *J Am Coll Cardiol Img* 2011;4:496-502.
2. Schlett CL, Banerji D, Siegel E, et al. Prognostic value of CT angiography for major adverse cardiac events in patients with acute chest pain from the emergency department: 2-year outcomes of the ROMICAT trial. *J Am Coll Cardiol Img* 2011;4:481-91.
3. Pundziute G, Schuijf JD, Jukema JW, et al. Prognostic value of multislice computed tomography coronary angiography in patients with known or suspected coronary artery disease. *J Am Coll Cardiol* 2007;49:62-70.
4. Min JK, Dunning A, Lin FY, et al., for the CONFIRM (COronary CT Angiography EvaluatioN For Clinical Outcomes: An InteRnational Multi-center Registry) Investigators. Age- and gender-related differences in all-cause mortality risk based upon coronary CT angiography findings: results from the international multicenter CONFIRM Registry of 23,854 patients without known coronary artery disease. *J Am Coll Cardiol* 2011. In press.
5. Hausleiter J, Meyer T, Hermann F, et al. Estimated radiation dose associated with cardiac CT angiography. *JAMA* 2009;301:500-7.
6. Raff GL, Chinnaiyan KM, Share DA, et al., for the Advanced Cardiovascular Imaging Consortium Co-Investigators. Radiation dose from cardiac computed tomography before and after implementation of radiation dose-reduction techniques. *JAMA* 2009;301:2340-8.
7. Motoyama S, Sarai M, Harigaya H, et al. Computed tomographic angiography characteristics of atherosclerotic plaques subsequently resulting in acute coronary syndrome. *J Am Coll Cardiol* 2009;54:49-57.
8. Miller JM, Rochitte CE, Dewey M, et al. Diagnostic performance of coronary angiography by 64-row CT. *N Engl J Med* 2008;359:2324-36.
9. Ostrom MP, Gopal A, Ahmadi N, et al. Mortality incidence and the severity of coronary atherosclerosis assessed by computed tomography angiography. *J Am Coll Cardiol* 2008;52:1335-43.
10. Budoff MJ, Dowe D, Jollis JG, et al. Diagnostic performance of 64-multidetector row coronary computed tomographic angiography for evaluation of coronary artery stenosis in individuals without known coronary artery disease: results from the prospective multicenter ACCURACY (Assessment by Coronary Computed Tomographic Angiography of Individuals Undergoing Invasive Coronary Angiography) trial. *J Am Coll Cardiol* 2008;52:1724-32.
11. Shaw LJ, Min JK, Narula J, et al. Sex differences in mortality associated with computed tomographic angiographic measurements of obstructive and nonobstructive coronary artery disease: an exploratory analysis. *Circ Cardiovasc Imaging* 2010;3:473-81.
12. Hulten EA, Carbonaro S, Petrillo SP, Mitchell JD, Villines TC. Prognostic value of cardiac computed tomography angiography a systematic review and meta-analysis. *J Am Coll Cardiol* 2011;57:1237-47.
13. Taylor AJ, Cerqueira M, Hodgson JM, et al. ACCF/SCCT/ACR/AHA/ASE/ASNC/NASCI/SCAI/SCMR 2010 appropriate use criteria for cardiac computed tomography: a report of the American College of Cardiology Foundation Appropriate Use Criteria Task Force, the Society of Cardiovascular Computed Tomography, the American College of Radiology, the American Heart Association, the American Society of Echocardiography, the American Society of Nuclear Cardiology, the North American Society for Cardiovascular Imaging, the Society for Cardiovascular Angiography and Interventions, and the Society for Cardiovascular Magnetic Resonance. *J Am Coll Cardiol* 2010;56:1864-94.
14. O'Gara PT, Ron Blankstein RT. The prognostic value of cardiac CT after coronary artery bypass surgery: as easy as 1, 2, 3? *J Am Coll Cardiol Img* 2011;4:503-5.
15. Schoenhagen P, Hachamovitch R, Achenbach S. Coronary CT angiography and comparative effectiveness research: prognostic value of atherosclerotic disease burden in appropriately indicated clinical examinations. *J Am Coll Cardiol Img* 2011;4:492-5.
16. Voros S, Rinehart S, Qian Z, Joshi P, Vazquez G, Fischer C, Belur P, Hulten E, Villines TC. Coronary atherosclerosis imaging by coronary CT angiography: current status, correlation with intravascular interrogation, and meta-analysis. *J Am Coll Cardiol Img* 2011;4:537-48.