EDITORIAL

Non-enhanced cardiac computed tomography—still an open book

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The assessment of coronary artery calcium (CAC) by ECG-gated non-contrast enhanced computed tomography (NCCT) has achieved widespread clinical acceptance as a measure of coronary atherosclerosis and future cardiac risk. A CAC score of 0 is associated with an excellent prognosis[1,2] while elevated levels provide incremental prognostic information above and beyond that of conventional cardiovascular risk factors in both Caucasian[3-5] and multiethnic populations.[6] Specifically, the CAC score has been consistently shown to be more predictive of cardiac outcomes as well as all-cause mortality than the Framingham risk score.[7,8] Guidelines have been increasingly favorable regarding the use of CAC scanning and currently the test is commonly used in asymptomatic patients for predicting future coronary events and in guiding the intensity of preventive therapies.

In this issue of *JNC*, Gupta et al report a novel application of gated NCCT obtained with the same study used for CAC assessment. They demonstrate a relationship between areas of hypo-attenuation on NCCT and irreversible defects on SPECT myocardial perfusion imaging. Using a cut-off of value of 27.2 HU, they report a sensitivity and specificity of 97.4% and 98.7% for the detection of non-reversible perfusion defects on post-stress and rest imaging with technetium-99m sestamibi.

Assessing the presence of prior myocardial infarction (MI) by NCCT could add significantly to the clinical value of NCCT. While the CAC score is strongly predictive of patient outcome, it is not highly predictive of coronary stenosis.[9] Knowing that a patient with coronary calcification had prior MI could help in the prediction of significant coronary artery disease from the NCCT. Further, since NCCT is increasingly performed as part of SPECT or PET–MPI studies, knowledge of prior MI could add to the information provided by the combined scans.

There are, however, several issues with the report by Gupta et al that suggest that the observations should be taken as preliminary. For example, they used standard rest sestamibi scanning to define non-reversibility of perfusion defects, and throughout the manuscript refer to the non-reversible defects as chronic MI. As mentioned by the authors, it is well known that hibernating myocardium could show non-reversible defects in patients without prior MI,[10,11] and that the prediction of prior MI is enhanced by the use of nitroglycerin prior to the rest injection with sestamibi imaging. Given this limitation, it would have been preferable for them to use the term ''non-reversible defect'' rather than MI throughout the manuscript. Further, as pointed out by the authors, a primary limitation of their study was that on standard rest sestamibi was used as the reference standard for non-reversible perfusion defects. It would be expected that hibernating regions would have been incorrectly classified as infarct by their approach. In addition, ''visual assessment of perfusion abnormalities by the referring physicians'' was used to define the presence and location of the non-reversible defects. Given the known high variability of visual assessment of SPECT–MPI by experts,[12,13] significant inaccuracy among the various readers in the detection and location of the perfusion defects must have been present, such that repeat expert visual reading or quantitative analysis of the data would have been preferred.

Thus, while this provisional data are interesting and demonstrate an additional potential use of NCCT, further validation is required. It would be important to examine the findings with more specific infarct imaging modalities such as cardiac magnetic resonance imaging (CMR), FDG-PET, or possibly nitroglycerin-augmented Tc-99m agent SPECT[14] or Tl-201 rest-redistribution SPECT prior to clinical use.

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If validated in additional studies, information regarding MI using NCCT would likely be of clinical use in patients undergoing stress imaging studies. In patients undergoing PET/CT or SPECT/CT, gated NCCT is frequently performed. The finding of hypo-attenuation on NCCT could provide complementary information to the perfusion study, aiding in distinguishing MI from attenuation artifact. Further, hypo-attenuation on NCCT, along with the coronary calcium score, may add predictive value in estimating the likelihood of coronary disease and, thus, improve the overall accuracy of perfusion imaging. Finally, as noted above, the information regarding prior MI could aid in predicting significant CAD in patients undergoing CAC scanning alone.

There has recently been renewed interest in the additional anatomic measurements, aside from the coronary arteries, that can be obtained from NCCT in order to best predict the likelihood of developing cardiac disease. Nasir et al[15] demonstrated that, by applying a validated algorithm,[16] measurements of left ventricular volume on NCCT correlated with end-diastolic volume obtained by CMR. Lin et al[17] reported a relationship between aortic root dimensions on NCCT and comparative measurements from transthoracic echocardiography and Wolak et al[18] have established normal ranges of thoracic aortic measurements for age, gender, and body surface area.

Another application of NCCT that is gaining momentum is the measurement of epicardial fat volume (EFV). Epicardial and thoracic fat are routinely imaged on NCCT and there is now emerging evidence that EFV is an important parameter in cardiovascular risk stratification and appears to provide incremental prognostic information regarding future cardiac events over that provided by CAC scanning alone.[19,20] In contrast to coronary calcium that provides a snapshot of the historical lifetime build up of atherosclerotic plaque, EFV may represent the current state of atherogenesis activity within the coronary arteries.[8] Recent data also suggest an intriguing relationship between EFV and myocardial ischemia.[21,22] Although the mechanism of the relationship of coronary atherosclerosis and epicardial fat remains unclear, initial studies indicate that peri-coronary epicardial fat is associated with atherosclerosis in the coronary arteries.[23]

The study of Gupta et al provides further evidence that the gated NCCT scan should not simply be considered a coronary calcium scan. As additional substantiating studies emerge, it is plausible that measurements such as LV size, thoracic aortic measurements, epicardial fat, and possibly assessment of prior MI may well become a routine part of the NCCT. The radiation dose associated with NCCT is falling[24-26] and the additional clinical imaging parameters that can be extracted from this data are increasing. The chapter on coronary calcium may soon be considered written, but the pages on NCCT keep turning. The story is far from complete.

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