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EDITOR'S PAGE

Cardiac Computed Tomography 2.0

Adding Physiology to Anatomy

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Computed tomography angiography (CTA) is now an established diagnostic option for patients with chest pain. It is a safe alternative to functional testing, provides diagnostic certainty (1), is a good gatekeeper for downstream invasive angiography, and increases the diagnostic yield when invasive angiography is eventually needed (2). CTA-driven care is associated with more relief of angina (3,4) and generates optimal medical therapy (5) associated with reduced death and myocardial infarction (6). However, CT angiography can lead to more cardiac catheterizations as well as more coronary revascularization (2). CTA shows good sensitivity, but also suffers from suboptimal specificity; thus, one cannot be sure, lacking other functional test results, that more revascularization procedures are necessary or beneficial compared to operating on lesions with demonstrated ischemia.

What to do after CT identifies a significant stenosis remains unclear. Three randomized controlled trials from Europe reported in this issue of *iJACC* clarify the use of value-added cardiac CT applications such as CT-derived fractional flow reserve (FFR) and CT perfusion (CTP) to assess the hemodynamic severity of angiographic lesions.

CT-FFR is an effective test in trials (7) as well as in the real-world milieu (8,9), and knowledge about CT-FFR changes practice (10,11) and outcomes (12). Newer technology may ease its use (13,14), and some guidelines are already positive for its role (15). However, its superiority over other noninvasive functional tests in still not clear, which makes the study by Sand et al. (16) very timely. These investigators compared CT-FFR and myocardial perfusion imaging by single-photon emission computed tomography (SPECT) performed in the same patient and using invasive FFR as the gold standard. By studying CTA of stenoses of intermediate severity, the authors focused on the lesions where functional information had most to contribute but were most vulnerable when it came to classifying hemodynamic significance (17). CT-FFR was the most sensitive technique (91%), identifying nearly all functionally significant lesions, which was offset by a specificity of only 55%. Although previous studies have also showed some degree of underestimation by CT-FFR, in this study, the specificity was lower by comparison (7,18). SPECT showed contrasting performance, not great but still better specificity (86%) than CT-FFR, offset by a sobering sensitivity of 41%. Once again, it shows that there is no perfect test and that one should harness the strengths and limitations of each technique to answer specific clinical questions.

Cardiac CT is a good test for rapid discharge of patients with acute chest pain presenting to the

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emergency department. Once patients have been discharged, guidelines call for stress testing in the early follow-up period to assess for flow-limiting coronary artery disease. This allows for the use of advanced CT applications, where a test with high specificity (CTA+CTP) may improve decision making over a test with just high sensitivity (e.g., CTA). CTP can improve clinical decision making (11) and may even be better (19). In the theme of harnessing the advantages of different testing strategies, the CATCH-2 trial (20) randomized patients to a undergo a standard CT angiogram or a CTA combined with myocardial perfusion imaging (CTA+CTP). Although the primary endpoint (revascularization in patients sent for invasive angiograms) was, interestingly, high in both groups and, surprisingly, no different, the total invasive angiograms and total revascularizations were significantly less in the CTA+CTP group. Adding physiology to anatomy may show clearer benefit in a more robustly powered future trial.

The value of adding physiology (CTP) to anatomic imaging was also part of the randomized, multicenter CRESCENT-2 trial (21), but now in the context of stable chest pain. Compared to standard care by stress testing, a tiered CT protocol (calcium scan followed by a CT angiogram, if calcium was present, and a dynamic myocardial perfusion scan in case stenotic disease was observed) provided a faster diagnosis, required fewer additional tests, and decreased the number of invasive angiograms that did not require intervention. Although the catheterization rate was similar for both groups, 88% of patients in the CT arm showed coronary artery disease with an indication for revascularization, compared to only 50% in the functional testing group. By leveraging the high negative predictive value of calcium imaging and CT angiography to rule out coronary disease, while reserving perfusion imaging to guide catheterization and revascularization decisions, median cumulative radiation dose was 3.1 mSv. Adding value-added CT techniques, especially in a tiered manner, may thus improve efficient decision making.

Both the CATCH-2 and CRESCENT-2 trials underline the value of functional testing once coronary stenoses are found on CT angiography. Contrary to some prior trials, these studies showed cardiac CT does not need to be associated with more invasive procedures and that both approaches can lead to more meaningful revascularization decisions based on a comprehensive evaluation of anatomy and function. *iJACC* is an ardent supporter of evidence-based studies, and imaging has been an area with a noticeable deficiency in randomized controlled trials. It is gratifying that we could bring you 3 such trials that will impact future thinking in evaluating patients with intermediate degrees of coronary artery stenosis. This issue of *iJACC* also offers a tantalizing prospect of tiered strategies for optimum clinical utility and may help convince the clinical community to think about an upgrade to cardiac CT version 2.0.

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