Calcium Imaging in the Emergency Department
Between a Rock and a Hard Place

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The triage of patients with acute chest pain is a clinical challenge encountered by physicians on a daily basis. It is also a logistic challenge, associated with long periods of observation and monitoring, contributes to overcrowding of emergency rooms, and is associated with substantial cost. Coronary computed tomographic (CT) angiography has long been considered a means to improve diagnostic uncertainty and alleviate the logistic burden in the triage of acute chest pain. During the past decade, a series of randomized clinical trials have tested the value of cardiac CT for patients with low–intermediate risk chest complaints and demonstrated that in comparison with standard care or specific other diagnostic tests, CT angiography is equally safe but can permit substantially earlier hospital discharge. Although CT angiography has an excellent negative predictive value, there is a reciprocal tendency to overestimate the angiographic and hemodynamic severity of coronary artery disease, particularly in patients with high calcium scores. Consequently, CT is associated with more diagnostic and therapeutic invasive procedures, blunting the potential for cost saving. Based on these observations, the question emerges whether CT angiography is equally effective in patients with a high atherosclerotic burden and whether the test should perhaps be avoided in patients with extensive coronary calcification.

See Article by Bittner et al

In this issue of Circulation: Cardiovascular Imaging, Bittner et al combined data from the ACRIN-PA-4005 (American College of Radiology Imaging Network, Pennsylvania Department of Health-4005) and the ROMICAT-II (Rule Out Myocardial Ischemia/Infarction Using Computer Assisted Tomography-II) trials, to investigate the association between the calcium score, downstream testing and associated costs, and the diagnostic yield of invasive angiography. The combined cohort consisted of 1234 mostly low-risk patients with acute chest pain, who were originally randomized to the CT arm of each respective trial. The investigators report that, as expected, the calcium score is positively associated with downstream testing, invasive angiography, and revascularization rates. Coronary artery disease prevalence and acute coronary syndrome (ACS) rates were also higher in patients with a higher calcium score. When medical efforts were proportioned to clinical outcome parameters, the downstream testing and medical costs per ACS turned out lower in patients with a high calcium scan compared with those with a low calcium scan. Based on these results, the authors conclude that the higher rates of downstream testing in patients with extensive coronary calcification are appropriate, and therefore, a high calcium score should not be considered a contraindication to CT angiography in patients with acute chest pain.

A higher disease burden explains and perhaps justifies more frequent downstream testing and revascularization, but does a proportional invasive catheterization rate directly imply the appropriate use of resources? Although not investigated, and perhaps impossible to do, is whether the CT scan itself is equally appropriate across calcium scores in terms of providing incremental information for patient care. In patients with a low or absent atherosclerotic burden, one can imagine CT angiography was often the conclusive test that resulted in (early) discharge. In patients with more diffuse disease, exclusion of disease is less frequently possible, and further invasive or noninvasive testing more often required. It is difficult to accept that for a population as diverse as patients with acute chest pain, 1 single test suits all. It would be interesting to determine the direct effect of CT angiography on patient management and address the impact of the calcium burden or other patient characteristics on this process in future studies.

The authors should be complimented for bringing together the data of these 2 landmark trials. This article and joint analyses that may follow, further educates us on the clinical value of cardiac CT in the setting of acute chest pain. In addition, these trials provide valuable insight into the contemporary management of acute chest pain, the relatively low prevalence of disease and rate of adverse events, and the relentless efforts to reduce risk further. Nevertheless, the triage of acute chest pain is (as always) in transition. Around the world, high-sensitivity troponin assays have changed clinical practice dramatically. Myocardial infarction can be excluded with high accuracy within a few hours or less after presentation at the emergency department. In this new context of standard care, earlier reported advantages of cardiac CT in terms of length of hospital stay are difficult to reproduce. The latest troponin assays even permit 0/1-hour rule-out algorithm. A potential drawback of high-sensitivity troponins is the higher false-positive rate, or more accurately, a larger proportion of patients with detectible troponins without an immediate benefit from invasive angiography or revascularization. In
the acute setting, the use of cardiac CT may shift from low-risk patients with negative troponins to those with borderline blood test results in whom invasive procedures can be avoided. The ongoing RAPID-CT trial (Rapid Assessment of Potential Ischaemic Heart Disease with CT) will investigate the value of cardiac CT in patients with nonconclusive positive troponin results. However, troponins do not exclude coronary stenosis or stable angina pectoris. Further workup may still be needed after an ACS has been ruled out, for which cardiac CT can be an appropriate option. Practical issues aside, this assessment of (stable) coronary artery disease could safely take place in an ambulatory setting. Cardiac CT has also further evolved during the past decade. Newer scanners image coronary artery disease more accurately at lower radiation doses and are less susceptible to artifacts. In addition, functional applications like myocardial perfusion imaging and CT angiography–based fractional flow reserve have also further evolved during the past decade. Newer scanners image coronary artery disease more accurately at lower radiation doses and are less susceptible to artifacts. In addition, functional applications like myocardial perfusion imaging and CT angiography–based fractional flow reserve can provide important incremental information to guide therapeutic decisions. A semielective daytime setting is better suited for high-quality CT angiography and functional CT applications.

As emphasized by the authors, costs are disproportionately high (per ACS) in calcium-negative patients. Although not the primary objective in this study, these results do beckon the question of what the value of calcium imaging is, or could be, in the triage of acute chest pain. The ability of calcium imaging to rule out ACS in low-risk patients has been demonstrated repeatedly, and a negative calcium score is associated with an excellent prognosis. The combined data in this study similarly demonstrate the high negative predictive value of a negative calcium scan. There was a single myocardial infarction in ≈800 patients with a negative calcium scan, whereas another 3 patients were classified as unstable angina. Interestingly, all patients with a calcium-negative ACS were women. It seems a calcium scan would have mis-triaged these women, although more clinical information would be needed to draw a definite conclusion. Particularly in women, pathophysiology other than fixed epicardial obstruction should be considered, and it would be interesting to know whether epicardial coronary artery disease was identified on CT angiography in these women. Although CT angiography obviously provides more information than a calcium scan about noncalcified plaque or noncoronary pathology, and the stakes are high in the context of a potential ACS, appropriate use of diagnostic studies also requires consideration of potential hazards related to contrast medium and radiation exposure, in addition to incremental effort and costs. In both trials, calcium imaging was performed without a specified clinical purpose, as it has been a part of clinical routine elsewhere for a long time. Although the relative contribution in terms of radiation exposure was considered negligible in the past, this situation has now changed. The radiation exposure of CT angiography has decreased dramatically. With state-of-the-art scanners, the dose of the CT angiogram can even be lower than a conventional calcium scan in some patients. Given the increased relative dose contribution of the calcium scan, it may be time to decide: should calcium imaging have a diagnostic purpose, or do we drop the acquisition entirely?

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