Computed tomography calls out nuclear imaging in its field: It doesn't matter how you are searching but what you are looking for

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In the current issue of the Journal, El Mahdiui et al¹ investigated the relationship between coronary artery calcium (CAC) score and inducible myocardial ischemia on computed tomography (CT) perfusion in 131 patients with stable chest pain demonstrating the independent predictive power of CAC score in identifying myocardial ischemia.

The relationship between the extent of calcified plaque and the presence of myocardial ischemia has been widely investigated with consistent implications for cardiac risk assessment and prediction.^{2–4} In particular, inducible myocardial ischemia can be assessed by myocardial perfusion imaging that is a non-invasive imaging test performed so far by two robust techniques: single-photon emission-computed tomography and positron emission tomography. Both methods for myocardial perfusion imaging are considered cornerstones for the diagnostic assessment and risk stratification of patients with suspected coronary artery disease. On the other hand, coronary calcium accretion as measured by the CAC score is strictly associated to atherosclerosis progression; therefore, its estimation is a valuable marker of disease advancement. Although it has been proven that the potential predictive role of CAC is complicated by evidence of substantial differences in the prevalence and extent of coronary calcification among various ethnic groups, the Multi-

Ethnic Study of Atherosclerosis (MESA) found that measurement of coronary-artery calcium in a multi-ethnic American cohort added incremental value to the prediction of coronary heart disease over that of the standard coronary risk factors in each of the enrolled ethnic groups.⁵

Furthermore, asymptomatic individuals without detectable calcium (CAC score of zero) have a very low (0.27% per year) risk of future cardiovascular events during the subsequent 3–5 years suggesting to choose a less aggressive pharmacotherapy strategy in this category of subjects.⁶ The consistence of this findings, by means “the power of zero”, has led American College of Cardiology and the American Heart Association to recommend the assessment of the CAC-score to guide decisions for statin therapy.⁷ Likewise, the diagnostic and prognostic value of CAC detection is so proven that a novel concept to assign a CAC score-based age to individuals regardless chronological age is indeed recently emerging.⁸

Given that, on the light of the large body of evidence provided by the literature,^{9–13} on one side there is an increasing awareness that both anatomical and physiological information are needed to guide a successful patient management and on the other there is a growing interest in developing a technique that is able to provide morphological and functional data as fastest as possible with minimal radiation exposure. Further, this goal should be achievable at low price and with valuable accuracy. Therefore, the wave of this enthusiasm has led to the development of stress CT perfusion imaging, a novel non-invasive imaging method for the detection of myocardial ischemia consisting in three different approaches: perfusion with conventional CT, with dual-energy CT, and dynamic perfusion CT.¹⁴

In addition to specific ability of coronary CT arteriography in evaluating global coronary plaque burden with regards to its lipid and calcified composition,

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myocardial perfusion imaging with conventional CT and with dual-energy CT allows a visual assessment of alterations in myocardial density or iodine mapping; while, dynamic perfusion CT offers quantitative assessment of myocardial blood flow providing comprehensive clinical information regarding quantitative flow estimation and myocardial perfusion reserve.¹⁵ All these potentialities make CT perfusion imaging very promising as all-in-one option for CAD evaluation. What is more, given the fast procedure profile, the detection of inducible myocardial ischemia by CT perfusion imaging could be particularly suitable in symptomatic subjects as next-door technique to rule patients in cath lab. Nevertheless, despite the great attractive of the method, there are still some challenges to take in to account.

The main concern that should be addressed is the lack of standardization in the evaluation of severity and extent of disease as indeed provided by semi-quantitative scores in nuclear cardiology.¹⁶ From a technical point of view, motion and beam-hardening artifacts are relevant issues affecting the quality of obtained images and thus the quantitative and semi-quantitative myocardial perfusion assessment. In particular, a cardiac scanning free from motion artifact, necessitates a relatively long breath hold of more than 30 seconds that can be difficult in fragile patients. Moreover, the presence of high atomic number materials, such as implantable cardiac devices and leads may cause beam-hardening effects.¹⁷ Although the introduction of next-generation CT scanners and more optimized protocols show promise in lowering radiation doses, according to the dose-optimization concept much effort is still required to achieve the average total dose already provided by low-dose stress-myocardial perfusion imaging protocols.^{14,18,19} Further, even if recent trials evaluated the relationship of CT perfusion imaging approaches and more invasive procedures,²⁰ large multicenter investigations are required to assess prognostic power of cardiac CT perfusion imaging not only by referencing to coronary angiography but also in comparison with other already widely validated non-invasive techniques. Beyond the overcoming obstacles that may be addressed in the next future it should be considered that some patients categories will never get benefit from CT perfusion imaging. For example, patients with impaired renal function may be affected by contrast nephropathy. Similarly known allergy to an iodinated contrast agent represents a not negligible factor to take in to account.

Yet, there is such a trust in traditional myocardial perfusion imaging parameters that there is a great effort in making CT able to provide the same information derived from nuclear imaging techniques. However, this trend has two main implications. First, it confirms how

robust is perfusion imaging as non-invasive instrument to address patients to more aggressive cares. Moreover, it seems that we are going in to the era in which the various techniques tend to be equivalent so that it doesn't matter how you do it, that is actually related to available resources, but what are you really evaluating.

The optimal technique choice is subject to different factors such as patient's characteristics, the device accessibility, the skilled personnel availability and the imaging cost-effectiveness. It becomes clear that, if on one hand, there is need to improve techniques to make all different methods comparable in answering to clinical questions, on the other hand it is also essential to increase multimodality imaging training. Indeed, CT perfusion imaging is not so widely spread in diagnostic setting and, not all cardiac imaging readers are able to perform this technique. Further, although CT might do it similar or even potentially better to nuclear imaging, there is still a lot to achieve, mostly in terms of standardization, radiation dose exposure reduction, validation and prognosis.

Disclosure

Carmela Nappi, Valeria Gaudieri, and Alberto Cuocolo declare that they have no conflict of interest.

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