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EDITORIAL COMMENT

End of the Road for Delayed Hyperenhancement Cardiac Magnetic Resonance?*

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Delayed hyperenhancement cardiac magnetic resonance (DHE-CMR), although considered a robust technique for the determination of myocardial viability, nonetheless has perceived shortcomings as a result of relatively long scan times, pacemaker/defibrillator incompatibility, and, more recently, concerns over development of nephrogenic systemic fibrosis when using gadolinium in patients with severe renal dysfunction (1). In this issue of *iJACC*, Chang et al. (2) propose delayed contrast-enhanced multidetector computed tomography (DCE-MDCT) as an alternative to DHE-CMR, circumventing the latter's shortcomings. Further, they implement a modification to significantly reduce the radiation dose, blunting one of the primary concerns of MDCT scanning.

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This investigation extends a topic of great research and clinical potential. Previously this group has shown that retrospectively gated DCE-MDCT is comparable to DHE-CMR in detection of large myocardial scars in a porcine model (3). In the current study, the investigators used a similar model of acute myocardial infarction, albeit using electrocardiographic prospectively triggered DCE-MDCT scans with an intention to reduce radiation dose. Compared with a standard retrospectively gated DCE-MDCT scan, the investigators showed significant radiation dose savings, without a reduction in image quality, as measured by signal-to-noise and contrast-to-noise ratios.

The potential for determining myocardial scarring in combination with an MDCT scan for the evaluation of coronary vessels/bypass grafts and left ventricular function in a relatively rapid examination argues for a particularly compelling diagnostic advantage. However, the use of MDCT in coronary applications alone remains controversial along multiple lines of reasoning, but particularly as a result of the high radiation burden (4–6). Indeed, routine use of standard retrospectively gated MDCT scans for coronary artery and scar assessment would heighten these concerns, because it would necessitate acquiring 2 separate scans and potentially double the already significant radiation burden. In the process of reducing this burden, the prospectively triggered DCE-MDCT acquisition by Chang et al. (2), with its attendant radiation dose savings, presents an attractive alternative. In fact, if the prospectively triggered technique is extended to the submillimeter slice, coronary artery scan, "back of the napkin" calculations suggest that this combination (coronary artery and myocardial scar imaging) might be even lower in total radiation dose than a typical retrospectively gated coronary artery examination alone.

Nonetheless, before we jump onto the prospectively triggered bandwagon, we need to consider the potential shortcomings of prospectively triggered scans. First, prospective scans, under most circumstances, do not allow for assessment of left ventricular volumes or systolic function. Second, to avoid step artifacts using typical 64-slice MDCT scanners, a well-controlled and stable heart rate in the 50s to 60s is essential (although this concern may be blunted with the advent of more extended range configurations, such as the 8- to 16-cm z-axis detector scanners). Frequently, adequate beta-blockade is necessary for reducing heart rate. In the clinical arena, such myocardial viability imaging is

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likely to be performed in patients with varying degrees of heart failure, situations in which aggressive control of heart rate may be more problematic. Third, image quality in obese patients using prospective scanning presents challenges for adequate tube flux, and therefore image quality. Finally, concerns over the small but real potential for nephrotoxicity with iodinated contrast agent remain.

To draw a distinction, let us examine some of the potential strengths of CMR as a diagnostic tool in the properly selected patient population. First and foremost, it is rapidly gaining the position (if not already there) as the gold standard in myocardial viability imaging (7). Further, CMR can accurately and reproducibly measure left ventricular function and volumes, as well as providing quantitative information about valvular function, including mitral regurgitant fraction (8). In addition, in experienced centers, ischemia evaluation is performed concomitantly (9). Electrocardiographic prospectively triggered DCE-MDCT currently is incapable of providing this same breadth of data. Also, CMR obtains all of this information without concern for radiation exposure. Another practical point to take into account concerns the patient population in which myocardial viability imaging is most important, namely those undergoing surgical revascularization. In most large centers, including our own, cardiothoracic surgeons have yet to embrace MDCT coronary angiography, instead still relying on traditional invasive angiography. And lastly, DHE-CMR has an established and growing wealth of data establishing its safety and prognostic utility (10–12).

We also recognize additional continuing technical challenges for DCE-MDCT in humans. In our own preliminary experience, performing DCE-MDCT using standard human doses of iodinated contrast (approximately 80 to 100 ml) yields images that are signal limited, have suboptimal contrast-to-noise ratio, and in general are of lesser quality compared with standard DHE-CMR. If we were to extrapolate the contrast dose used in the study by Chang et al. (2) for use in humans, a dose of 2 to 3 times the current dose would be necessary. Such a dose of iodinated contrast augers for heightened caution in a population with potentially tenuous renal function (i.e., patients with ischemic cardiomyopathy and congestive heart failure). At present, it is not at all clear what the optimal contrast dose and technique are for DCE-MDCT myocardial infarct and viability assessment. If indeed the contrast dose requirement is found to be higher, the safety of such a strategy needs to be ascertained; single-center and multi-center trials will also be needed to prove its reproducibility and utility.

Despite the breadth of concerns surrounding the practicality and utility of and the radiation incurred with DCE-MDCT, the technique cannot be discounted. This technology remains early in development, whereas the broad advances in cardiac MDCT over the past few years—improvements in temporal resolution, prospective triggering to reduce radiation dose, number of detectors, dual-source and dual-energy scanners, and so on—have been dramatic. No doubt similar advances will occur in the arena of MDCT myocardial viability determination. For now, DHE-CMR remains the clear frontrunner, although DCE-MDCT may soon become a reasonable alternative in patients not amenable to CMR. Further developments in DCE-MDCT portend budding challenges to DHE-CMR, and healthy, expanded debate.

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