Dual-Energy (Spectral) Late Iodine Enhancement Cardiac CT: Does a Dual-Layer Detector Make It Work?

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Conflicts of interest are listed at the end of this article.

See also the article by Oda et al in this issue.

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Many investigators have evaluated the use of late iodine enhancement (LIE) imaging as a CT analog of late gadolinium enhancement (LGE) for evaluation of scar and fibrosis in both ischemic and nonischemic heart disease; however, it has found limited clinical use because of difficulties related to sensitivity. Dual-energy or spectral CT has been suggested as a way to improve image quality in LIE imaging through the use of low kiloelectron voltage (keV) monoenergetic and iodine density images. While demonstrating some improvement in performance, specifically in imaging of myocardial infarction and for stress perfusion studies, image quality has been disappointing when using both dual-source and rapid kilovoltage-peak switching techniques for dual-energy imaging, and these methods have not found their way into common clinical application.

In this issue, Oda et al (1) report on dual-energy cardiac LIE imaging using a dual-layer detector system. The authors found improved image quality using monoenergetic images at 50 keV compared to that at standard 120 kVp or iodine density imaging. They also demonstrated high accuracy of both monoenergetic and iodine density imaging compared to that at cardiac MRI for detection of areas of late enhancement in both ischemic and nonischemic heart disease, including hypertrophic cardiomyopathy and cardiac amyloidosis. Finally, they found excellent correlation between CT- and MRI-derived extracellular volume fraction, a method that can be used for quantification of diffuse myocardial fibrosis and for the diagnosis of infiltrative disorders such as amyloidosis.

These results are not unexpected and have been demonstrated in studies involving other methods for acquisition of dual-energy CT data. What is striking about the application of dual-layer detector technology is the visible improvement in image quality compared to other methods, particularly for low keV monoenergetic and iodine density images. This difference in dual-energy image quality related to the use of a dual-layer detector has been observed in organ systems as well, and as the authors explain, is likely related to the concept of "anticorrelated noise" between the set of material decomposition basis sinograms obtained in the spectral acquisition. By performing a joint reconstruction, which takes this knowledge about the noise into account, it can be dramatically decreased on the resulting images. Although the authors do not explicitly state it in the article, this requires the use of a dedicated

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model-based iterative reconstruction (MBIR) method. This same MBIR method was not applied to the 120 kVp images, which were reconstructed with the manufacturer's previous hybrid iterative reconstruction method, perhaps creating a somewhat unfair comparison.

While the images certainly look very nice, and there was excellent agreement for detection of late enhancement on a per-segment basis compared to that at cardiac MRI, we must be cautious in application of the results of this study generally, particularly for evaluation of nonischemic heart disease. This is well-illustrated by the authors' case of hypertrophic cardiomyopathy in figure 2; while the CT images clearly identify right ventricular insertion point late enhancement, to my eye, there is also faint septal midmyocardial LGE on the MR image that might not be prospectively identified with CT. As the amount of myocardium demonstrating late enhancement has been shown to predict risk of arrhythmia in hypertrophic cardiomyopathy, accurate quantification is essential for appropriate management. The retrospective nature of this study, the small group of patients who underwent both CT and MRI (only 21 of 40), and the mix of ischemic and nonischemic disease will not be enough to prove the accuracy of dual-layer dual-energy CT–derived late enhancement, and larger prospective studies with comparison to MRI will be needed before CT can be applied routinely in these cases.

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Reference

1. Oda S, Emoto T, Nakaura T et al. Myocardial late iodine enhancement and extracellular volume quantification with dual-layer spectral detector dual-energy cardiac CT. Radiol Cardiothorac Imaging 2019; 1(1):e180003.