Fusion Images: More Informative Than the Sum of Individual Images?

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There are a number of examples in cardiovascular investigation where the images are created predominantly for an attractive display, but may not be particularly useful from either a clinical or a research standpoint. One such example is 3-dimensional (3D) display of computed tomography (CT) coronary angiogram, which provides a striking silhouette but is of little help in making the correct diagnosis. Unlike merely decorative representations, fusion imaging is a means of image display that has been touted as an important strategy in cardiovascular diagnosis. It has been proposed that the future of multimodality cardiac imaging lies in the amalgamation of different modalities that bring their individual strengths to bear (1).

The most successful example of fusion imaging is the superimposition of the positron emission tomography (PET) or single photon emission computed tomography data on CT images. Overlays of the physiology derived from the nuclear data, and the anatomy derived from CT, are synergistic and greatly enhance the diagnostic capabilities of either technique alone (2). The myocardial perfusion images can uncover the functional significance of a coronary artery lesion of indeterminate severity observed on a CT angiogram. In this way, the combination of 2 imaging modalities is greater than the sum of its parts and aids in clinical decision-making. The additive radiation burden remains an issue to be resolved.

Successful hybrid imaging has also been frequently employed in the electrophysiology (EP) laboratory, where the available cardiac magnetic resonance or CT images are fused with electroanatomic maps generated in the EP lab for optimal mapping of the left atrium prior to atrial fibrillation ablation (3). Also in the EP arena, useful information is obtained by mapping of scar-related ventricular tachycardia using hybrid PET/CT imaging (4).

Fusion of PET and magnetic resonance (MR) is beginning to be performed on prototype scanners designed for brain imaging with a PET insert within a magnet. Although problems with this approach remain to be fully resolved, larger and more complex body imaging systems are expected to follow, with the potential to support cardiac indications. The most attractive application is proposed to be a fusion of these 2 modalities for myocardial viability assessment (5), which would be able to combine the PET metabolic information with the anatomic information obtained from late gadolinium-enhanced (LGE) cardiac magnetic resonance.

Combined anatomic and physiologic information may not always require 2 different imaging modalities. The ability to synthesize anatomic and physiologic information is possible by combining LGE and low dose dobutamine assessment of contractile reserve for viability within the same regions of myocardium, an approach which is especially useful in subendocardial infarction (6).

The concept of within-modality fusion imaging is further exemplified by the study of White et al. published in this issue of iJACC (7). The authors acquired LGE images in a multislice manner with whole heart coverage and 3D navigator-based coronary angiography in 55 patients. They combined these 2 datasets into one 3D display of the LGE and coronary arterial and venous angiographic anatomy. They found that this informa-
tion was useful to clinicians in 2 settings: prior to coronary artery bypass grafting in multivessel coronary artery disease and prior to cardiac resynchronization therapy (CRT) for congestive heart failure. Fusion imaging was successful in 85% of patients with myocardial scar by LGE and the lack of success in the remaining instances was due to lower image quality and hence inadequate 3D scar segmentation. A large number of the studies were demonstrated to have clinical impact; in almost two-thirds of patients coronary artery bypass surgery was initially planned to a territory with transmural scar, and in 40% of patients a transmural scar was noted in the region where a left ventricular pacing lead was planned for CRT. Transmural scar in the site of lead placement, particularly in the posterolateral left ventricular wall is known to be associated with a lack of response to CRT. Thus in this study, fusion therapy with LGE and coronary MR angiography demonstrated tangible clinical benefits by refining planned therapy. This is an important proof-of-concept study wherein a beautiful set of fusion images goes hand in hand with impact on clinical decision making. A potential next step would be a prospective trial that compared management with and without the fused image sets.

Where will fusion imaging go in the future? Will it be primarily within a single modality such as presented in the current study (7), or will it employ multimodality imaging as a combination of PET-CT or PET-MR? It will be important to demonstrate incremental clinical and cost-effective benefits of the fusion imaging approach. Because there are substantial economic pressures to keep the cost and amount of imaging down (8), the bar will be set relatively higher for the applicability of within- and cross-modality fusion imaging. The onus is on us, the imaging community, to continue to demonstrate not only that we can offer pretty pictures, but that these images make a difference in patient care and outcomes.

REFERENCES

6. Bove CM, DiMaria JM, Voros S, Conaway MR, Kramer CM. Dobutamine response and myocardial infarct transmu-