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iVIEW

EDITOR'S PAGE

EP Goes Imaging

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In our very first issue in 2008, we promised that *JACC: Cardiovascular Imaging* would be a very visual platform that not only showcases the imaging sciences, but also brings on a smile to the reader's face. The images on this month's cover page of *iJACC*, of a research paper from Leiden (1), visually show the power of an impressive new multimodality combination of techniques. Elements of virtual reality (that in its fundamental domain is just complex imaging) and fiction are creeping into the diagnostic technology. We may soon feel like passengers in an adventure, albeit without the adrenaline rush of decimating legions of bad guys and flirting with comely aliens. However, there indeed may be a gratification of mastering complex multimodality techniques and the thrill of flirting with the might of the potential of complex imaging.

In this paper (1), using real-time fusion of computed tomography (CT) datasets with fluoroscopic imaging and electroanatomical mapping during epicardial ablation of ventricular arrhythmias, the authors were able to integrate both the thickness of the epicardial fat layer and the proximity of their ablation catheter to the coronary arteries into the intraprocedural decision-making process with the thought of avoiding ineffective as well as potentially harmful ablation sites. Their work combines high-end medical care in many aspects: epicardial ablation is an advanced intervention, fusion with electroanatomical mapping adds procedural complexity as far as equipment and processing is concerned, and cardiac multidetector row CT, especially in a real time lab environment, is among the most difficult applications of CT imaging. Further, color-coding of epicardial fat thickness, co-registration with the ablation catheter position, and image fusion within the electrophysiology (EP) lab environment add to the challenge. All the same, the authors (1) and the editorialists (2) concluded that the combination of various imaging techniques were feasible and provided incremental value for the EP procedure.

The alliance between imaging and EP is clearly coming of age, and their futures appear to be intensely intertwined. EP is making more and more use of advanced imaging to guide and facilitate their interventions and imaging is contributing in many more ways each year. On one hand, imaging can provide valuable information *before* EP procedures (3–9). Based on the work under discussion here, and as pointed out in the accompanying editorial, the thickness of epicardial fat may be an important consideration before an epicardial ablation procedure; a fat thickness >7 mm may not be conducive for a successful epicardial ablation. The investigators have moved from simple imaging uses like excluding thrombi before atrial fibrillation ablation procedures (9) or the analysis of ventricular dyssynchrony (3,4,5), to more complex uses like demonstrating scar (5,6,7) that might affect procedural outcome and define anatomy that might affect procedure strategy (7,8).

On the other hand, as in the present study (1), the image guidance *during* the procedure (coronary angiography and CT imaging) was found to be useful for identifying catheter position relative to coronary arterial branches. This is an area of intense growth. In addition to the standard use of CT or magnetic resonance reference images for pulmonary vein ablation, more advanced applications may find use in improving procedure results such as the use of positron emission tomogra-

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phy–CT data during the ablation procedure to identify scar borders (10), or to reduce radiation exposure, such as by the use of 3-dimensional transesophageal echocardiography guidance during ablation (11,12). Even entire ablation procedures have been performed with magnetic resonance imaging (13,14). Finally, imaging may also play an important role *after* the ablation procedure; magnetic resonance imaging allows definition of atrial and ventricular scars which could help predict the likelihood of a recurrence (15,16). Although attractive, there are problems and even adverse outcomes with adding imaging studies to EP interventions, including, but not limited to radiation exposure and contrast agent use. Besides, it adds to the cost of the procedure. Complex imaging will require qualified personnel to execute and interpret the test. In the specific case of imaging guidance for EP procedures, imaging knowledge alone may not be sufficient, and expertise in EP may need to be integrated, either by cross-training imaging experts, or establishing close communication between imaging and interventional physicians.

Why have we witnessed such an extended use of multimodality imaging and fusion in electrophysiologic (ablation) procedures in recent times? First, these interventional procedures are long and complex and imaging helps facilitate catheter guidance and orientation in the heart. The mean procedural duration in the present paper was more than 4 hours (1). Since the procedural effort is already quite high, there is a low threshold for adding another piece of equipment or imaging study in order to help and shorten the study. This is similar to coronary intervention wherein the additional imaging procedure is used only during long and often elaborate procedures such as the recanalization of the segments with chronic total occlusion (17). Second, electrophysiologic interventions benefit from information on anatomic orientation, scarred versus viable myocardium, cardiac function, and the pattern electrical activation. Since no single imaging modality could provide all the information, the use of multiple modalities and their co-registration or fusion is being attempted. It is expected that the combination of high-end imaging and interventional technology will at least allow better understanding of the disease procedure.

A few issues need to be carefully considered among all this excitement. When introducing such complex real time imaging in the milieu of the EP lab, we have to be very clear what our primary goals are. Are we just looking for a better way or a real time way of identifying anatomy, or are we looking to providing real time guidance for the procedure over and above the anatomy. We have to clearly show that there is a need for this extra element of complexity and that doing so helps more than what imaging we currently have. Proving a clear benefit is becoming an increasingly complex task, since most outcome measures are soft, pertaining to physician ease or satisfaction. On the contrary, the hard endpoints, such as reduced complications (including perforations) are not primarily related to lack of information from techniques like fusion mapping. Procedural success might be one endpoint, but the EP techniques themselves are evolving and have yet to arrive at a normative range for such endpoints. Could most of the information be obtained preprocedure (so that there is not a space/time/expertise issue in the lab) and intraprocedure sophisticated imaging be limited with the least amount of cost and risk (e.g., intracardiac echocardiography or 3-dimensional transesophageal echocardiography vs. more complex imaging)? Should scarce resources be spent on introducing sophisticated new modalities or should we improve the efficiency curve of existing and already proven techniques in use like intracardiac echocardiography (depth resolution etc). Could we use sophisticated nontraditional mathematical methods like hierarchical segmentation (which may identify elements with common characteristics among a jumble of signals) to extract information out of current imaging datasets instead of using yet another costly and complex modality to generate another cardiac imaging dataset? It will be a rewarding day for imaging when "a cardiac dataset is a cardiac data set" and can be fruitfully exploited no matter how it came about.

In the future, we will be able to bring in a lot of advanced technologies and be excited about much of the new imaging methods. In the words of our famous science fiction fantasies—go where

no man has gone before. But while fictional adventurers and Dr. McCoy could write their own story and say snappy and spine tingling things like "Roads? Where we're going, we don't need roads," sophisticated medical imaging, like the fusion imaging described here, has still to traverse the asteroid belt of cost, benefit and utility. Even so we remain believers and our snappy comeback remains "may the force of imaging continue to be with you."

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