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President's Page

Beyond the Bleeding Edge

Just how difficult is it to achieve a clinical aim with cardiovascular magnetic resonance (CMR)? Is it getting easier? And is CMR of any use in coronary artery disease? These are questions asked of me by cardiology colleagues interested to know if and when CMR will make a more significant impact on their clinical practice. CMR has achieved a variety of cardiac investigations for several years already, but the difficulty of use and the lack of commercial postprocessing has held them "at the bleeding edge," that is to say achievable, yes, but hard work and restricted to specialist centers, yes. This is a problem of both perception and reality that CMR has to overcome. What must we do to move beyond the bleeding edge? Below I consider three areas where we seem ready to make a greater clinical impact and some simple steps that would help us along this path.

The question of implementation of stress CMR reminds me of a collaborator whom I asked for permission by letter to study his patients undergoing coronary angiography with stress CMR using dipyridamole and dobutamine in 1989 (1,2). "Of course, but why use a sledgehammer to crack a nut?" was his reply. I was annoyed at the time because as a researcher this was hardly the point, but now I see how far out on that edge we were. Ten years later we are still in the process of making a very good test clinically acceptable, whereas stress echocardiography has become widely adopted despite its arrival later on the scene and its relative shortcomings compared with CMR (3).

So what is holding stress CMR back? First, the realities: We need the CMR equivalent of the echocardiography quad-screen display, which is off-line but adjacent to the scanning console and immediately available, to allow review of the images while scanning continues (4). The data need to be ported to this screen as soon as it is acquired and held there for constant review of new wall motion abnormality. New cines need to be added as they are acquired and displayed in a logical manner. In fact, there is no reason to limit the cine display to 4 as in echocardiography, and multicine displays of up to 30 sectors showing five image planes with successive dobutamine doses for ease of diagnosis and monitoring should be the aim. Separate continuous display of real-time wall motion might also augment the comfort zone for the monitoring process, in the absence of reliable electrocardiographic data (5). In addition, CMR aficionados must become more comfortable with the administration of dobutamine and atropine, and scanner rooms need to be designed to help in this regard. I recently saw a useful innovation at the Deutsches Herzzentrum in Berlin where the dobutamine infusion pump is kept in the control room with the operator and the long infusion line passed through a waveguide to the scanner room and then to the patient. Simple, but effective in keeping the physician in control by ensuring that pump dysfunction does not occur and allowing dose changes to be achieved with ease. Second, the perceptions: We need to increase the throughput of such examinations worldwide in the clinical setting to demonstrate that this is not just a test performed in ivory towers. We should start by pointing out the one area where stress CMR has been shown to be helpful, which is in patients with reduced image quality with echocardiography (3,6). We also need to build confidence in referring physicians that CMR can do the job quickly and, in particular, safely. Good patient monitoring within the magnet remains a significant issue of perception for mainstream cardiology (7), and this needs to be demonstrated in large patient numbers. Demonstrable maintenance of skills in resuscitation by the operators is also vital for the test to become accepted, because serious dysrhythmias may occur (8). Each center must consider how best to achieve this nontrivial task according to its local situation, and the training and experience of its operators.

The second area is resting ventricular function, which

is now receiving the attention it deserves. There is no more basic test of physiology that is a major predictor of outcome in coronary artery disease and valve disease, and CMR has now given us accuracy and reproducibility to measure ventricular mass and volumes quickly and easily. From being a 45-minute examination in the 1980s, the technique has been transformed by the use of the segmented FLASH cine to a 10-minute procedure that can be used in addition to anatomical assessment in the same scan appointment. Today, ultrafast techniques make breathhold three-dimensional coverage of the heart feasible (9). Using such techniques, we and others have set up CMR heart failure clinics (10). At Royal Brompton Hospital, this is operated much like an echocardiography clinic with the patients walking in before seeing their cardiologist for review and leaving in less than an hour with a paper report and selected images printed on paper, for filing in the notes and not a film store. What is holding back this clinical application of CMR? This seems to lie in the postprocessing and the need for high profile publications demonstrating the value of CMR and when it should be used in preference to other techniques. It is a reflection on the relatively low contrast between blood and myocardium in CMR cines that there is still no robust processing package that saves manual drawing of up to 40 contours to yield the results for resting ventricular function. There are some attractive packages available with good user interfaces, but they only work well on the very best data sets and still require a lot of operator intervention, which is not a solution for real life. In addition, the issue of the identification of the atrioventricular valve plane, particularly on the end-systolic images, remains problematic. Thus, both the acquisition needs to be improved in contrast (possibly with an intravascular contrast agent (11) and the three-dimensional nature of the problem needs to be recognized, with proper valve plane measurement using integrated long- and short-axis imaging. As for the definition of the role of CMR within cardiology, too few comparisons of the performance of the techniques in clinical practice and outside research settings have been reported. This needs to be addressed and the relative clinical merits of the techniques clearly identified (12).

As for the third area, what of perfusion? Clinical comparisons suggest that CMR techniques are candidate rivals to radionuclide single-photon emission computed tomography (13). The newest scanners allow us to perform multislice two-dimensional imaging at rest and during stress in two first-pass data sets with adequate ventricular average. This is a big improvement on the early days of single-slice perfusion with one image per cardiac cycle at rest. However, to deliver a clinically relevant procedure, we need to deliver a clinically meaningful output. We cannot expect clinicians to view 10 two-dimensional cines of first-pass data and compare the rest and stress data without help. We need to condense those 500–1000 frames into one to two parametric images and print this with the interpretation. Thus, we return to postprocessing. Where are commercial programs to correct for respiratory motion, curve-fit the pixel signal changes, extract the slope data, and perform a bull's-eye representation of the collapsed left ventricle, as we do every day in nuclear cardiology (14)? Without them, the technique will remain a research curiosity.

Thus, as we move beyond the bleeding edge, we need to focus on a few key areas. We must refine and accelerate the acquisitions, but let's get behind the computer scientists who need much more support, feedback, and encouragement to push CMR to the next level of clinical acceptability. Only then can the clinicians really get on with larger comparative validation studies showing cost effectiveness and useful outcomes.

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