Picture my heart!

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If you are like me, you find the new cross-sectional imaging techniques visually attractive but nonetheless bewildering. Don't despair! This issue contains a series of articles on the subject of cross-sectional imaging, starting with basic principles and ending with cutting-edge innovations in technology.

What we would all like for our patients is a 'one-stop shop' that will tell us how well the heart is working now and what the future may hold in terms of risk of coronary events. It will be clear from reading the following articles that, at present, no single imaging technique in its current state of development can deliver this performance, although the authors do point out that both cardiac magnetic resonance imaging (MRI) and computed tomography (CT) are not that far from this ideal when used in specialist centres. However, these techniques differ markedly in a number of respects, including exposure to ionizing radiation, and ability to assess myocardial perfusion and delineate the coronary anatomy. Furthermore, neither technique currently provides metabolic information. How are these conclusions reached?

This issue starts with a review of the physical principles that underlie the generation of images by MRI, CT, and positron emission tomography (PET). From this it is clear that PET provides a very high signal-to-noise ratio, but resolution is constrained by the positron travelling perhaps several millimetres in tissue before colliding with an electron. This collision creates the annihilation event that results in the high-energy photons that are detected by the coincidence counter. Thus the photons may emanate from a point millimetres away from the location of the PET tracer. This may not sound a great distance, but it can be important when PET tracers are used to visualize small structures such as active atherosclerotic plaques. The other problem with PET is that the anatomy surrounding the tracer is not visualized; these soft tissues can be visualized by CT and MRI. The physics of CT is relatively easy to understand and, as Dr Boellaard points out, the technique provides low intrinsic contrast between soft tissues in the absence of a contrast agent. Conversely, the physics of how precession of protons within water gives rise to the signal that builds the MRI image is incomprehensible, to me at least. However, the signal does provide a high intrinsic contrast between different soft tissues, even in the absence of a contrast agent. The complementary information obtained by PET compared with CT and MRI provides the basis for synergy in the form of PET/CT and PET/MRI and puts CT and MRI in direct competition for the imaging of the myocardium and blood vessels.

The article by Drs Schuijf and Bax provides a concise overview of the relative advantages and disadvantages of MRI, CT, and PET from a clinical perspective. In addition, these modalities are placed in the context of widely available techniques such as echocardiography and single photon emission computed tomography. Once again, the complementarity of PET with CT or MRI is highlighted, further building the case for hybrid imaging. It is also clear that the hardware for CT is evolving fast, with more detectors and X-ray sources. The current state-of-the-art 64-slice scanners are likely to be superseded, whereas it seems most of the innovation in MRI is driven by software, with 1.5T scanners still being most common. Another important difference is the ability of the techniques to visualize coronary anatomy. Here, CT clearly leads but is still unable to define precisely the degree of luminal narrowing, especially in the presence of calcification. Although MRI is not able to compete in coronary artery imaging, it can do so in terms of relative myocardial perfusion. This is becoming a well-accepted technique, despite the lack of quantitative information which, at present, can be provided only by PET.

The article by Dr Kaufmann highlights the advantages of PET. However, it also points out that, despite these advantages being known for decades, PET cardiac imaging has not been adopted widely. It is likely that the use of hybrid imaging techniques and the miniaturization of cyclotrons will increase its popularity. At present, PET remains the gold standard technique with which to visualize viable metabolically active myocardium that is not contracting as a result of hibernation. However, it is possible that the natural history of hibernation/repetitive stunning can also be uncovered by imaging for scar using late gadolinium-enhanced images visualized by MRI.

Finally, we get a brief glimpse of the future of cardiac intervention, without radiation, using real-time MRI. At present this technology offers limited temporal and spatial resolution. However, these limitations are likely to be overcome through innovative software solutions and new MRI-friendly intravascular catheters and guides.

In reading this issue, I have realized how quickly cardiac MRI and CT are evolving. It will not be long before they supersede coronary angiography as the gate-keeper to revascularization. As to whether to spend money on a magnetic resonance or CT scanner... at present, I would buy both! One for now and the other for later. I will leave you to guess which way around. ■