

PET: Speed Dating CT or MRI?

In 1998, a German-based company, in collaboration with its U.S.-based corporate partner, announced the installation of a combined PET/CT prototype system in a clinical environment. Two years later, an attendee of the annual meeting of the German Society of Nuclear Medicine (DGN) described PET/CT as the “death of nuclear medicine.” However, in late 2001, one of the first commercially available PET/CT tomographs—and the first in Germany—was installed at the University Hospital in Essen. At the time, just over 10 PET/CT systems were operational worldwide, accounting for 2% of all PET installations. The fraction has now risen to over 50%, and the number of clinical PET procedures has more than doubled, according to a recent survey by Stergar and colleagues at 6 German university hospitals.

PET/CT now appears to be strengthening the nuclear medicine profession worldwide by bringing molecular imaging to the forefront. Was it the appeal of PET, or the attraction of yet another dual-modality combination, that was the reason the German-based company announced in 2005 the development of a combined PET/MRI system specifically for clinical applications? In a number of ways, the path to PET/MRI has been reverse of that to PET/CT. The first PET/CT design emerged from industry-academia collaboration and was a prototype for human clinical use that eventually stimulated a commercial response and led to the development of PET/CT for imaging small animals. In contrast, PET/MRI began with the small-animal design and then, over a decade later, the first PET/MRI brain images were acquired on a dedicated prototype system, following an impressive industrial backing that far exceeded that of the early PET/CT developments.

Extensively documented evidence exists that PET imaging affects the staging and management of cancer patients, and there is no doubt that PET should be offered in addition to the currently reimbursed anatomic imaging procedures. For example, in a little over 5 y, ^{18}F -FDG PET/CT has come to dominate noninvasive imaging in oncology. The power of PET/CT lies not only in the added value that each modality brings to the other but also in the increased confidence with which the images can be interpreted. The use of the CT images for noiseless



attenuation correction of the PET data, the improved quality of the PET images, and the 10-min whole-body scan times greatly benefit the patient. It is now interesting to speculate on the future clinical impact of PET/MRI and how it will affect, if at all, the clinical utilization of PET/CT.

It may well be that the clinical success of PET/CT will be the biggest challenge to a widespread adoption of clinical PET/MRI. In addition to the technological challenges, attenuation and scatter correction will be more problematic with PET/MRI. The large installed base and increasing adoption of PET/CT, or even SPECT/CT, may make it harder for PET/MRI to rival existing clinical applications of combined anatomic-functional imaging, even though PET/MRI has the potential to dominate in other areas of non-invasive imaging. In neurology, for example, the simultaneous mapping of MRI spectroscopy and molecular changes may ultimately lead to new insight into brain activation or may support neurosurgical intervention.

Nevertheless, it is not without irony that PET/MRI is being developed largely in Germany, a country that remains among a handful in Europe without uniform reimbursement for PET or PET/CT procedures. Is it likely that this situation will change with the installation of the first clinical PET/MRI scanners in 2007? Probably not, because this is an ongoing situation that not even PET/CT could change. (One wonders how many combinations of PET with a reimbursed anatomic imaging modality it will take before PET imaging too is reimbursed.)

In view of the expanding range of multi-modality imaging options, efficacy studies

are increasingly justified to help establish the appropriate choice of imaging techniques for a particular disease or clinical indication. These studies should, where appropriate, involve both standalone and combined imaging modalities, even though most advanced PET technology today is available only in combination with CT. These studies may eventually demonstrate that refining scan parameters and optimizing imaging protocols is a preferable way to reduce exposure of patients to radiation than would be avoiding radiation altogether, especially in those patients who need a prompt and accurate diagnosis.

Independently of such efficacy studies, PET/CT potentially receives an immediate benefit from the ongoing development of PET/MRI in that compact, avalanche photodiode-based PET detector designs developed for PET/MRI may eventually replace the photomultiplier-based PET detectors in PET/CT tomographs. Such developments may further stimulate the search for a common detector for both CT and PET, thus opening the possibility of simultaneous PET and CT scanning.

A mere 2 y after the advent of commercial PET/CT, Johannes Czernin from UCLA, at the 2003 annual DGN meeting, commented that “PET/CT is a technical evolution that has led to a medical revolution.” Today, at the dawn of PET/MRI, it may be said that “PET/MRI is a medical evolution based on a technical revolution.” Although PET/CT appears to have replaced stand-alone PET for most oncologic indications, it is reasonable to assume that PET/MRI will be the preferred imaging option for neurologic and central nervous system indications. Without doubt, such dual-modality combinations are here to stay because they incorporate the diagnostic power of PET. Thus, PET/CT and PET/MRI, by virtue of their combined anatometicabolic imaging, will lead to a “new-clear” medicine and the demise of “unclear” medicine.

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