Dedicated Solid State Cardiac Systems for Myocardial Perfusion Imaging

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Multiple Detector Systems

Myocardial perfusion imaging (MPI) has evolved from planar scintigraphy to single detector single-photon emission computed tomography (SPECT) imaging, to dual detector SPECT imaging to our present state of multiple (more than two) detector SPECT imaging. In recent years manufacturers have begun to break away from the conventional SPECT imaging approach to create innovative designs of dedicated cardiac imagers. These imagers' designs have in common that all available detectors are constrained to simultaneously imaging just the cardiac field of view. These new designs vary in the number and type of scanning or stationary detectors, and whether crystals or solid state detectors are used.[1,2,3]

Three commercially available cardiac-centric SPECT systems exist which use multiple solid state detectors and have been validated in multicenter clinical trials. These are: (1) the Digirad® Cardius, which uses 3 parallel hole collimator cameras consisting of cesium-iodide (CsI) crystals/diode module detectors[3], (2) the Spectrum Dynamics D-SPECTTM, which uses 9 cadmium-zinc-telluride (CZT) fanning detectors with tungsten parallel large hole collimators[4], and (3) the General Electric Discovery NM 530c, which uses 19 CZT static detectors with pinhole collimators (tungsten insert).[5] In the CZT-based systems the conventional photomultiplier cameras with sodium iodide (NaI) crystals have been replaced with CZT solid state detectors which have a superior energy and spatial resolution. These improvements come about because the energy of the photon being imaged is converted directly to an electrical pulse within a 2.46 mm2 pixel. This direct conversion preserves the energy information much better than the conventional cameras that use the Anger camera electronics and is resolved in a single small pixel.

These systems have in common the potential for a 5 to 10 fold increase in effective count sensitivity at no loss or even a gain in energy, spatial and contrast resolution, resulting in the potential for acquiring a stress myocardial perfusion scan injected with a standard dose in 2 minutes or less or in trading off some of this added count sensitivity for a reduction in the injected dose at comparable image quality. Studies have shown that images from these solid state imagers using conventional myocardial perfusion imaging (MPI) doses of 10 mCi for rest and 30 mCi from stress acquired at 4 min for rest and 2 min for stress are of higher quality and at least of equal diagnostic value than those acquired on conventional two-detector SPECT cameras using 14 min for rest and 12 min for stress acquisition.[4,5] Other studies have shown that with these multiple detector imagers the injected dose may be reduced by half (5 mCi rest/15 mCi stress) and the rest images acquired in 8 min and the stress in 5 min and still yield images of superior quality over conventional acquisition times with conventional SPECT systems.[6]

Reduced Dose vs. Increased Efficiency

The increased count sensitivity of these new systems may be traded off for a reduced injected dose and, thus, a reduced total effective dose to the patient. It is clear that these more efficient imaging systems also allow for high-quality images that are obtained using a lower injected radiopharmaceutical dose and, thus, a decrease in the radiation dose that is absorbed by the patient and staff. This reduction in dose comes at an increase in acquisition time, even if the total time is still less than what has been traditionally used in conventional systems. Recently, the American Society of Nuclear Cardiology published an information statement[7] recommending that laboratories use imaging protocols that achieve on average a radiation exposure of less than or equal to 9 mSv in 50% of the studies by 2014. Although there are many different protocols that may be implemented to accomplish this exposure goal, use of the more efficient imagers described above would greatly facilitate this goal and allow for increases in efficiency over the imaging protocols used today.

References

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