EDITORIAL

The First-Pass Ventricular Function Study: Why Now?

For many years, imaging ventricular function depended upon the type of gamma camera available. In the beginning, single-crystal, low count-rate detectors and multicrystal, high count-rate detectors were available, each of which had its unique applications and neither of which could do what the other did. As a result, the clinical radionuclide imaging community divided into two camps, one committed to gated equilibrium radionuclide angiography (RNA) and the other to first-pass RNA. The overwhelming majority of laboratories were in the equilibrium camp because of the prevalence of single-crystal systems, the inability of the multicrystal camera to perform other cardiac and noncardiac imaging and the uneasiness of many nuclear medicine physicians and physicists in accepting the relatively low spatial resolution of early multicrystal cameras. In the mid 1980s, the first major reconciliation of the two camps occurred when a single-crystal camera with increased count-rate capability and the necessary software for acquisition and processing of high count-rate first-pass data was developed. Average clinical count rates of 150,000 cps were realized and both ejection fraction and wall motion assessment proved to be accurate (*1*). Despite that achievement, most vendors did not follow suit due in no small part to the lack of enthusiasm for this application on the part of the imaging community. Most of the demand and investigative effort over the past ten years has gone into the development and refinement of tomographic imaging systems and software. The application of first-pass RNA remained fairly restricted. So, why now, almost a decade after the original description of high count-rate first-pass RNA with a single-crystal camera, does the *Journal* publish the first confirmatory article on the subject?

The answer is the emergence of technetium-based myocardial perfusion imaging agents. First-pass RNA has recently been successfully performed with ^{99m}Tc-sestamibi (*2*), teboroxime (*3*) and tetrofosmin (*4*). Now, a single injection of ^{99m}Tc can be used to assess regional wall motion, measure left venticular ejection fraction (LVEF) with an accuracy comparable to contrast angiography, calculate left ventricular end-diastolic volume, quantitate diastolic ventricular function, qualitatively and quantitatively evaluate regional myocardial perfusion tomographically and, by gating the tomographic acquisition, even assess regional wall thickening. The nuclear imaging laboratory can now deliver the most comprehensive, noninvasive evaluation of the coronary disease process ever possible. echocardiography, fast-CT and MRI have not reached this plateau.

Combining Function and Perfusion Imaging

Prior to the introduction of technetium-based perfusion agents, there were attempts to combine function and perfusion imaging. The simultaneous injection of ^{195m}Au (half-life, 30 sec) and ^{201}Tl allowed acquisition of a first-pass study followed by perfusion imaging 10 min after the gold had decayed (*5*). Due to technical problems with the ^{195}Au generator, it was never considered safe enough to bring to market. A similar approach used the combination of ^{191m}Ir and ^{201}Tl (*6*). Despite the appeal of those approaches, it was the widespread clinical acceptance of the technetium-labeled perfusion agents that led to a resurging interest in first-pass RNA and combined-function perfusion imaging. The combination of ventricular function and myocardial perfusion imaging will undoubtedly prove to be superior to either modality alone. Preliminary data sugest that first-pass RNA has independent diagnostic power when combined with perfusion imaging (*2*). Other investigators have shown an enhanced ability to detect multivessel coronary artery disease when first-pass RNA is routinely added to perfusion imaging (*7*). Noncoronary causes of symptoms, such as diastolic dysfunction, cardiomyopathy or valvular insufficiency may become apparent after analysis of the first-pass data even when perfusion images are normal. The ability to visualize a wall-motion abnormality at peak exercise that corresponds to any given perfusion abnormality provides a more tangible appreciation of the functional impact of that perfusion defect. Patient management decisions are greatly facilitated when the interpreting physician has access to prognostically powerful exercise or resting LVEF data (*8*). With the combination of perfusion and function information, it may be possible to become more selective in the referral for invasive diagnostic and therapeutic procedures. And not to be underestimated is the increased diagnostic confidence of the interpreting physician when two independent results are concordant or when, as is so often the case, a perfusion scan is equivocal but the function study is completely normal. We believe that the frequency of false-positive perfusion scan results decreases when simultaneous ventricular function data are available.

The gated SPECT perfusion study is also an important advance in the area of combined function and perfusion imaging. Wall thickening can be qualitatively evaluated and LVEF can be estimated (*9*). Gated SPECT cannot be used to assess ventricular function at the time of injection, i.e., dur-

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ing exercise or pharmacological manipulation. It can only provide insight into the status of ventricular function at the time of tomographic acquisition (i.e. at rest). If first-pass RNA cannot be performed, and a technetium agent is used, at least one acquisition should be gated so that some assessment of ventricular function is provided. The assessment of ventricular function is an integral part of the evaluation of every patient with coronary artery disease. Patients undergoing diagnostic coronary arteriography invariably have contrast ventriculography performed at the same time. In this issue of the *Journal*, Nichols et al. take us another step forward in making the first-pass study more accessible. With the addition of an ultra-high-sensitivity collimator, technically satisfactory and clinically accurate first-pass RNA was performed with an otherwise unmodified commercially available single-crystal LFOV gamma camera. The clinician now has the option of multicrystal, single-crystal SFOV and single-crystal LFOV systems for performing first-pass RNA. With a SFOV single-crystal system, both perfusion and function data can be acquired with the same camera. In addition, preliminary data and an ongoing multicenter trial suggest that the multicrystal camera can be used for upright SPECT when coupled to a rotating chair.

Single-Crystal First-Pass RNA

A few technical considerations must be kept in mind. Single-crystal first-pass RNA requires a minimum dose of 20 mCi (740 mBq) for an average adult and larger doses for large subjects. Although successful attempts at first-pass RNA have been made with technetium-sestamibi, teboroxime and tetrofosmin, there is some doubt about the suitability of teboroxime for first-pass imaging (*10*). Few vendors offer the option of an acquisition matrix smaller than 64 × 64, but end-systolic counts/pixel and image quality may be marginal or unacceptable with a 64 × 64 matrix and average single-crystal count rates. Acquisition of first-pass RNA is fairly straightforward during bicycle exercise with the chest stabilized against the detector, but for treadmill exercise, a motion-correction algorithm that requires an external point source and dual-energy acquisitions is necessary (*11*) and that approach has not been applied to single-crystal systems. First-pass RNA requires large bore, proximal veins for bolus injections and specialized training is required for technologists to become adept at positioning and injection.

More work on first-pass RNA with single-crystal cameras is necessary. There is room for improvement in detectors, collimators and software. Biplane first-pass studies may soon be an option, further expanding our ability to interrogate LV function. There is also a need to increase the exposure of the technologist community to first-pass data acquisition. Many technologists complete training without ever having participated in a first-pass study.

The addition of first-pass RNA to myocardial perfusion imaging will come at a price, and in this era of cost containment the ultimate dollar value of added technology must be considered. It remains to be seen how often and in which clinical situations the combined study will be justified. The potential benefits appear to outweigh the cost, but rigorous proof of this concept is necessary.

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