LETTERS TO THE EDITOR

Tl-201 Single-Photon Emission Computed Tomography (SPECT)

Two conflicting papers comparing the 180° and 360° data collection for Tl-201 SPECT were recently reported (*1*,*2*) with a related Teaching Editorial by Dr. Hoffman (*3*). As a user of this technique for almost three years, I would like to offer the following observations, based on 1000 patients studies.

We use a filtered back-projection algorithm without attenuation correction for reconstruction and have observed that 180° data collection provides much better qualitative results than the 360° method. We now use the first procedure exclusively. The most obvious beneficial effect of the 180° was a decrease of the background activity in the reconstructed sections. Consequently there were fewer counts per section, but that resulted from the decrease from the background rather than a change in the absolute myocardial activity, which was only slightly affected. The reason for the decreased background is probably because in the right posterior projection most of the data collected are background counts, including scattered photons. As was emphasized by Dr. Hoffman (*3*), only 3 to 7% of the photons coming from the myocardium will reach the camera from this direction. As a consequence, there is an obvious improvement of the contrast between normal and hypoperfused myocardium, which was clearly shown by Tamaki et al. using 180° collection (*2*). Coleman et al. (*1*) found no difference in the contrast between the heart and the background when comparing the two methods of data collection; however, their 360° study was corrected for attenuation whereas the 180° one was not. Conversely, it is likely that the basal portion of the myocardium would benefit from a rotation of more than 180°, since the base is the most deeply situated cardiac wall. Hence the introduction of new algorithms allowing data collection with angular values between 180° and 360° should now be considered.

Dr. Hoffman (*3*) remarks that "the obvious area in which SPECT might excel is in quantitative measurements of tracer concentrations of new radiopharmaceuticals which, we hope, will have properties that will allow measurement of physiological rather than anatomical parameters." I believe that SPECT has demonstrated a superiority over planar imaging in the qualitative detection of Tl-201 defects (*4*,*5*) and that this role is established. The improved detection is of real clinical importance because the examination becomes more sensitive. In addition, the interpretation becomes much more objective. These advantages have led us to dispense with the planar imaging procedure in all the routine Tl-201 examinations in the Department of Nuclear Medicine. It is obvious that if reliable *quantitative* measurements can be achieved with SPECT, a major new field would be opened to nuclear medicine. In such an event, it is likely that 360° data collection would be more suitable. The quantitative data that can be obtained with 180° rotation may also have physiological significance, however, and further analysis may provide additional insights that are distinct from the anatomical interpretations. For example, it should be possible to compare the mean absolute myocardial uptake in a given patient with the values observed in a normal population. Or one could follow locally the temporal evolution of the uptake after stress exercise. Tl-201 SPECT appears to offer not only promise for the future but also real advantages now.

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REFERENCES

1. COLEMAN RE, JASZCZAK RJ, COBB FR: Comparison of 180° and 360° data collection in thallium-201 imaging using single-photon emission computerized tomography (SPECT): Concise communication. *J Nucl Med* 23:655–660, 1982
2. TAMAKI N, MUKAI T, ISHII Y, et al: Comparative study of thallium emission myocardial tomography with 180° and 360° data collection. *J Nucl Med* 23:661–666, 1982
3. HOFFMAN EJ: 180° compared with 360° sampling in SPECT. *J Nucl Med* 23:745–747, 1982
4. TAMAKI N, MUKAI T, ISHII Y, et al: Clinical evaluation of thallium-201 emission myocardial tomography using a rotating gamma camera: Comparison with seven-pinhole tomography. *J Nucl Med* 22:849–855, 1981
5. MAUBLANT J, CASSAGNES J, LE JEUNE JJ, et al: A comparison between conventional scintigraphy and emission tomography with thallium-201 in the detection of myocardial infarction: Concise communication. *J Nucl Med* 23:204–208, 1982

Reply

We have read with interest the comments of Dr. Maublant. We do not think the two papers comparing the 180° and 360° data collection for Tl-201 SPECT are in conflict. As the tables clearly show, the image contrast for Tl-201 in both phantoms and patients is similar with 180° collection without attenuation correction and with 360° collection with attenuation correction (*1*). Our study (*1*) and the study by Tamaki et al. (*2*), did not compare images in the same manner. Since the image contrast in our phantom studies and patient studies was similar for 180° without attenuation correction and for 360° with attenuation correction, we would have predicted similar image contrasts by the two techniques in patients with prior myocardial infarction. Since Tamaki et al. tabulated their data in a defect-to-normal ratio, these results cannot be compared with our image contrast results. Ours were obtained with a dual-detector SPECT system using a specific procedure for data acquisition and reconstruction. One criterion for our evaluation was the determination of the variability of the myocardial image contrast, C_{image} (defined as the count density within an ROI placed over the image of the myocardium minus the background count density, all divided by the background count density), for situations where the absolute myocardial uptake ratio, C_{obj} (defined as the difference between the radionuclide concentration within the myocardium and the background concentration, all divided by the background concentration), was known to be constant. For the phantom study, where C_{obj} is constant, our data

(Table 2 and Fig. 3) demonstrate that the 360° protocol results in less variability in the SPECT-measured contrasts. The observed variability in C_{image} results mainly from: (a) variations in the spatial resolution at different locations within the reconstructed image, and (b) variations in the Compton-scattered component at different locations. With our SPECT system and reconstruction algorithm, the 360° acquisition results in less variability in the spatial resolution throughout the reconstructed volume, compared with the 180° protocol. Furthermore, the effect of not applying an attenuation compensation to the 180° data results in a marked variability in the count densities of both the myocardium and the background, thus leading to difficulty in directly relating these count densities to absolute radionuclide activities.

We are interested in the comment that the improved images, despite fewer counts from the 180° collection, "resulted from the decrease from the background rather than a change in the absolute myocardial activity, which was only slightly affected." We have previously demonstrated (*3–6*), and Hoffman (*7*) has discussed, that the measured SPECT image contrast is dependent (even with an appropriate attenuation compensation) not only on the radionuclide uptake ratio, but also is affected by the inclusion of Compton-scattered photons, the reconstructed spatial resolution, the dimensions of the object, variabilities of the spatial resolution within the volume, and patient and/or organ motion. Thus it can be seen that the problems associated with extracting absolute radionuclide uptake ratios from SPECT-measured image contrasts are formidable. It has not yet been demonstrated whether absolute radionuclide uptake ratios can be measured accurately in vivo for the intact myocardium using SPECT-measured count densities. However, a necessary first step is that values of C_{image} for different portions of the myocardium be constant when the uptake ratio is constant. It may then be determined whether appropriate compensations can be devised for the physical factors described above, thus resulting in reasonably accurate measurements of *absolute* myocardial radionuclide uptake that can be used to describe quantitatively regional myocardial function.

We are interested in determining the real value of SPECT in Tl-201 imaging. Although the preliminary studies have suggested that SPECT imaging is superior to planar imaging, these studies have been done in highly selected patient populations. The role, if any, of SPECT imaging of Tl-201 in the evaluation of patients with chest pain using "exercise-redistribution studies," or of patients with chest pain and suspected infarction, is yet to be established.

Due to the limitations of Tl-201 for imaging, we certainly would prefer to be using a Tc-99m myocardial agent. Even if a Tc-99m agent should become available, however, careful attention to the collimators used for SPECT must be given. Furthermore, a method for making appropriate attenuation corrections for 180° data collection needs to be developed and evaluated.

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REFERENCES

1. COLEMAN RE, JASZCZAK RJ, COBB FR: Comparison of 180° and 360° data collection in thallium-201 imaging using single-photon emission computed tomography (SPECT): Concise communication. *J Nucl Med* 23:655–660, 1982
2. TAMAKI N, TAKAO M, ISHII Y, et al: Comparative study of thallium emission myocardial tomography by a 180° and 360° data collection. *J Nucl Med* 23:661–666, 1982
3. JASZCZAK RJ, COLEMAN RE, WHITEHEAD FR: Physical factors affecting quantitative measurements using camera-based single photon emission computed tomography (SPECT). *IEEE Trans Nucl Sci* NS-28:69–80, 1981
4. JASZCZAK RJ, COLEMAN RE, GREER K: The effect of source motion on lesion contrast with SPECT and conventional imaging. *J Nucl Med* 23:P44, 1982
5. JASZCZAK RJ, WHITEHEAD FR, LIM CB: Lesion detection with single-photon emission computed tomography (SPECT) compared with conventional imaging. *J Nucl Med* 23:97–102, 1982
6. BECK JW, JASZCZAK RJ, COLEMAN RE: Analysis of SPECT including scatter and attenuation using sophisticated Monte Carlo methods. *IEEE Trans Nucl Sci* NS-29:506–511, 1982
7. HOFFMAN FJ: 180° compared with 360° sampling in SPECT. *J Nucl Med* 23:745–747, 1982

Reply

Thank you for the comments, based on many patient studies, regarding 180° and 360° data collection for Tl-201 SPECT. I do agree with your statement about better qualitative results with 180° collection, since it provides better spatial resolution and contrast with less background activity than the 360° approach.

Coleman et al., using a cardiac phantom, described the effects of attenuation in the 180° scan. The effect of attenuation, however, will be overestimated if the phantom is placed in a water tank. Accordingly we have studied a new thoracic phantom, consisting of the lung, spine, and Tl-containing heart with a defect (Fig. 1A). Its "lung" consisted of sawdust with density 0.3 g/cm^3, and a "spine" of sand with density 1.8 g/cm^3. A perfusion defect in the

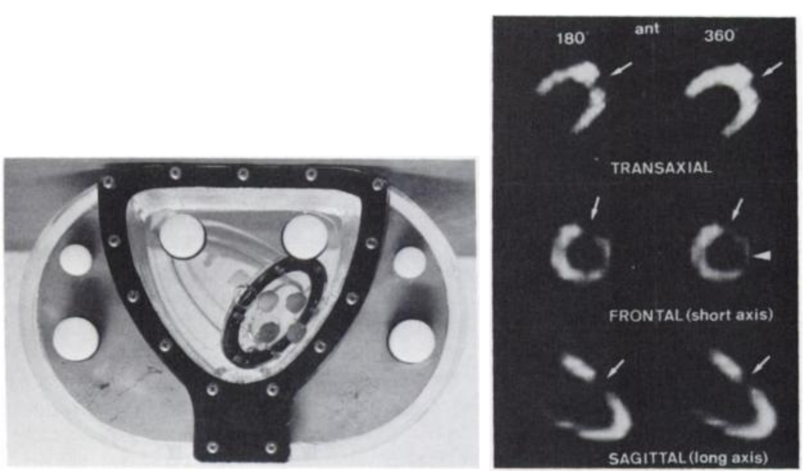

FIG. 1. Our thoracic phantom (A) and the ECT images obtained from the 180° and 360° scans (B).