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Gallium-67 Lung Index Computerization in Interstitial Pneumonitis

TO THE EDITOR: In the December 1987 issue of the Journal, Specht(*1*) et al describe an automated, computer assisted method for calculating the Gallium index.

Although it is always commendable to improve the quantitation and objectivity of studies, the completely automated approach seems to raise a problem in this instance. It is well known that the lower angles of the scapulae may show up on the posterior ^{67}Ga scans as foci of increased uptake. It is not always possible to move them out of the field of view by scanning the patients with the arms up. Neither is it always possible to exclude from the field of view the breasts which may have variable amounts of ^{67}Ga. In determining the ^{67}Ga index with manual drawing of ROI's these areas can easily be excluded from the calculations. How can these areas of extrapulmonary ^{67}Ga uptake be excluded when using the method proposed by Specht?

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REPLY: In our experience the scapular tip interference problem posed by Dr. Oster has not been a major concern for the following reasons: In more than 98 imaging studies performed for this purpose we have not seen sufficient uptake in this area to cause concern. In contrast, shoulder joint uptake was a potential problem which, as pointed out in the paper, was dealt with by outline regions of interest (ROI) which were drawn on an anatomic basis to exclude them.

Should a problem case like this arise that could not, in our opinion, be ignored, we would draw the lung region with a dip in it to avoid it. Either way, we would expect little effect on the index value because, as pointed out in the paper, the method was found to be relatively insensitive to lung margin errors. This insensitivity is partly due to the small numbers of pixels generally involved, and partly due to low differential count gradients in the normal chest between such areas and the lung parenchyma. In addition, the index of 50 as the normal/abnormal cutoff takes care of these problems in both methods to some extent. As with Line's method, we obtain the Indices by using only the posterior lung view. Should sufficient breast uptake be present to shine through to this view, our computer program permits the anterior view to be used for index generation. Again, ROI's could be drawn to exclude these areas in either view.

In conclusion, it should be remembered that the test using either method is designed predominantly to assess diffuse disease.

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First-Pass Radionuclide Determination of Cardiac Output: An Improved Gamma Camera Method

TO THE EDITOR: It was encouraging to read the recent article by Kelbaek et al. (*1*) describing their first-pass method for determining cardiac output. Cardiac first-pass techniques are greatly underutilized in many areas where equilibrium gated techniques are more widely employed. As the authors pointed out, first-pass studies provide truly different information about cardiovascular function, such as forward flow and valvular regurgitation (*2,3*) that is not available or that is less readily available from equilibrium gated blood-pool studies. It is thus encouraging to see more information and experience accumulating on these methods. A principal impediment to their use however, has been the general unavailability of software suitable for performing first-pass curve analyses.

In their paper, Kelbaek et al. present as a principal thesis that equilibrium, but not first-pass, background subtraction is necessary to avoid overestimating cardiac output by the radionuclide external indicator dilution approach. This assertion may not be generally applicable for the technique however, for several reasons.

First, no reference is made to the problem of count losses resulting from camera deadtime. Using the camera, collimator, and doses they employed, deadtime losses are considerable. Furthermore, count losses are greater during first-pass than during equilibrium counting. As a result, if corrections for deadtime are not employed, flow will be overestimated (*2,4*) via the equation.

$$\text{Flow} = \frac{\text{Qeq} \times \text{Vd}}{\text{Area}}$$

where Qeq is equilibrium count rate, Vd is dilution volume during equilibrium counting, and Area is area under the first-pass time-activity curve.

Second, in processing the first-pass time-activity curve from the left ventricle, they excluded the initial "hump" of activity in the right heart, coronary sinus, lungs, and other structures. This is an incorrect maneuver since Eq. (1) assumes that identical sources and sites of radiation are counted during both equilibrium and first-pass counting. Activity continues to scatter into the left ventricular region of interest during equilibrium counting, just as it did during the first-pass study. As a result of this exclusion, curve area is smaller, and flow is overestimated by Eq. (1). One might assume that the authors excluded this initial hump as a result of a lack of software to access functions other than the gamma variate for fitting the left ventricular time-activity curve.

Third, a gamma variate was used to fit the left ventricular curve. This function routinely underestimates curve areas and overestimates flow (*5*) compared to the more widely accepted technique of monoexponential extrapolation (*6*), which they appropriately employed for their reference method based on arterial sampling. For consistency, they could have used the same fitting function for both their test and reference methods. Again, one assumes that this reflected availability of software.

Fourth, the gamma variate fit was terminated at the time when recirculation was felt to occur. This is an extremely subjective decision, and in the vast majority of cases such a point can never be clearly ascertained, regardless of whether the data is plotted on a linear, semilogarithmic, or any other kind of scale. A monoexponential fit, customarily carried to a lower point on the descending portion of the left ventricular curve, would appropriately include first flow activity in other structures (e.g. aorta, chest wall, etc.) that also contribute to the equilibrium count rate. Exclusion of flow from these structures reduces the area under the curve and raises flow calculated by Eq. (1).

Thus each of the four difficulties mentioned above result in a relative overestimation of cardiac output by the technique that the authors employed. As a result, they found that lowering the equilibrium count rate by subtracting background tended to correct for other sources of overestimation.

Empirically, the authors found their approach useful, but it cannot be recommended in general. Difficulties could arise if one were to employ their approach with other cameras, other collimators, other doses of radionuclide, or alternative software for curve analysis. One could obtain very different results, and background correction as employed by the authors would not be appropriate. Methods for determining cardiac output using radionuclides should be carefully evaluated in each institution in which they are employed. Such quantitative methods should not be employed in the absence of appropriate software.

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REPLY: We appreciate Dr. Glass's interest in our paper (*1*), and we agree that radionuclide first-pass techniques have been underutilized. The following comments are offered to clarify the questions raised by Dr. Glass.

Using the Siemens mobile cardiac camera equipped with a low-energy, all purpose collimator, deadtime losses are undetectable in the field below 2×10^6 cpm. From 555 MBq technetium-99m in vitro labeled red blood cells we usually record peak left ventricular activities below 2×10^5 cpm.

Compton scatter from other sources than the left ventricle should be corrected for during first-pass by exclusion of the right ventricular scatter and during equilibrium by subtracting background activity as described. Alternative procedures for background subtraction may be usable, such as subtraction of the first-pass activity in an identical background area as that used at equilibrium (*1*). Gamma variate fitting of the first-pass, time-activity curve is a widely accepted technique for curve area calculation that gives reliable results (*2,3*).

Assessment of the point of recirculation is not a sensitive factor in the first-pass radionuclide determination of cardiac output. This is ascribed to the nature of the gamma variate fit function, and suggests further that this technique be employed for area calculation.

Glass et al. recently described a swift and elegant first-pass technique for cardiac output determination (*4*). Great caution should be exercised, however, in the clinical application of this method, that does not consider background activity after complete mixing of the tracer, a crucial point of the first-pass technique (*5–7*). By estimating the blood volume of cardiac patients from height and weight predicted values of healthy subjects, relatively small distribution volumes of the tracer may counterbalance the overestimated equilibrium activity. A thorough evaluation of any technique for measurement of cardiac output should be evaluated on location as stressed by Dr. Glass.

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