

Image Processing and Interpretation

Myocardial perfusion imaging (MPI) has become a relatively common test for assessing patients with suspected coronary artery disease (CAD). However, image acquisition, processing, and interpretation protocols can vary significantly between different nuclear labs. The following is a general overview of processing and interpretation of single-photon emission computed tomography (SPECT) images for the assessment of perfusion.

PROTOCOL VARIABILITY

Inter-lab differences exist not only in image acquisition procedures but also in processing and interpretation.¹ For example, some labs use attenuation correction, while others do not. Even among those that do use attenuation correction, differences exist in the data used for correction (moving line sources versus CT correction).^{1,2} Some labs rely heavily on quantitative analyses,³ while others rely solely on visual interpretation.¹ Approaches to quantitation also vary depending on the algorithm used,⁴ and visual interpretation requires an experienced reader and is associated with interobserver variability.⁵

PROCESSING PARAMETERS

Key SPECT image processing parameters include the following⁶:

Filtering—Filtering helps improve image clarity by removing noise and blur before and after backprojection of raw SPECT data.⁶ The Butterworth filter is the standard filter for SPECT, but the optimal order and cutoff varies by vendor.⁶

Reconstruction—Reconstruction reorients SPECT data to the 3 axes of the patient's heart, creating horizontal long axis, vertical long axis, and short axis slices⁶ (Figure 1). Image reconstruction has traditionally been performed using filtered backprojection.⁷ A wide variety of reconstruction filters and settings have been used, based on tracer characteristics and activity, system and collimator characteristics, and software used for analysis.⁸

Motion Correction—Inspection of cine display of planar projection data (ie, rotating images) is the recommended method of detecting motion because it demonstrates both vertical and horizontal motion.^{6,7} A static sinogram is also sometimes used but does not show horizontal motion.^{6,7}

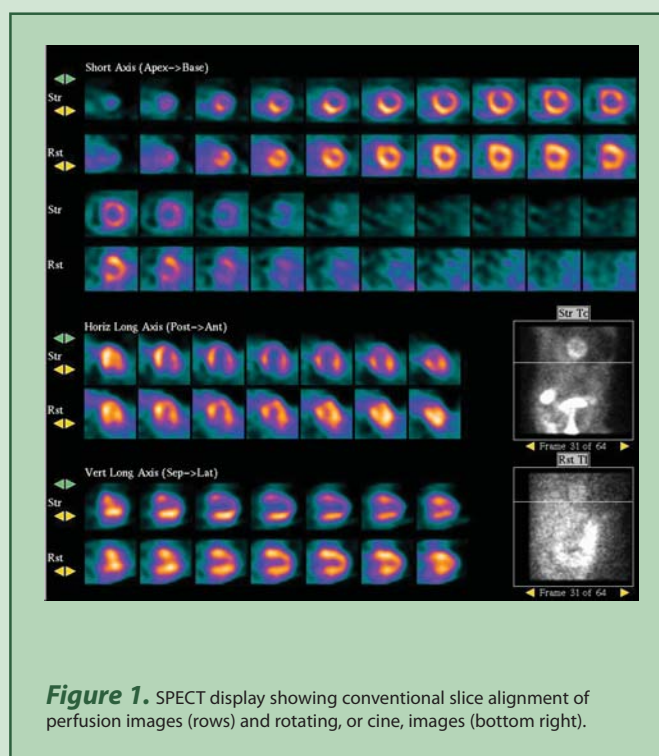


Figure 1. SPECT display showing conventional slice alignment of perfusion images (rows) and rotating, or cine, images (bottom right).

Attenuation Correction—The cine display of planar projection images is also recommended for identifying the sources of attenuation.⁷ If automated attenuation correction is used, the data should be processed first without attenuation correction and then reprocessed with attenuation correction.⁶ The corrected and uncorrected data should be read simultaneously, as the former may contain artifacts or overcorrections.^{6,7}

Quantitation—The degree of ischemia versus infarction can be assessed by quantitation of the stress images compared with the rest images.⁷ Quantitative analysis is usually displayed as a bull's-eye or polar plot.⁷ A number of software packages are available for quantitation of myocardial slices.⁶

Normal Database—Functional indices should be interpreted in reference to the gender- and protocol-specific normal database,⁴ which allows for calculation of the extent and severity of defects.⁶ Because approaches to quantitation vary, defining the normal limits and criteria for abnormalities for a specific quantitative program is necessary for optimal image interpretation.⁴

Left Ventricular Ejection Fraction (LVEF) and Volume—Quantitation of these functional parameters permits a systematic assessment of effects of the disease process on cardiac function, provides an objective basis for risk stratification and management, and allows for sequential follow-up of therapeutic response.⁴ A number of software packages are available to calculate LVEF.^{4,6} LV end diastolic and end systolic volumes can be estimated with the same software.⁶

IMAGE INTERPRETATION SEQUENCE

The sequence of SPECT interpretation is⁹:

1. Review raw cine projection (Figure 1). This allows visualization of any potential sources of artifacts that could result in misinterpretation.
2. Review perfusion data for defects, either fixed or reversible (Figure 1).
3. Review quantitative analyses for comparison. In practices with only a single interpreter, quantitation may be a good “second reader.”
4. Review gated SPECT data to assess wall motion and LVEF.

DATA DISPLAY

For interpretation, images are “normalized” for optimal visualization of the heart.⁶ They are then displayed in serial alignment, with each stress slice image directly above its matching rest counterpart, starting with the first apical rest and stress slices (on the left) and continuing through to the final basal slices (on the right).^{6,7,10} The horizontal long axis images are aligned from inferior (left) to anterior (right) slices, and the vertical long axis images from septal (left) to lateral (right) slices¹⁰ (Figure 1).

VISUAL INTERPRETATION OF PERFUSION DATA

It is recommended that the perfusion images be reviewed on a computer monitor because of the high resolution and the flexibility to adjust a variety of visual parameters.¹⁰ Linear gray scale is the color table recommended by many guidelines, but others can be used effectively. The most important aspect is that the operator be very familiar with the color table selected.¹⁰

To assess the images for perfusion defects, the reviewer looks for areas of decreased tracer uptake—ie, darker areas on the images. Defects that appear on both the stress and rest image are fixed defects. These usually represent myocardial scarring. Defects that appear on the stress image but not on the rest image are reversible defects. These represent coronary ischemia induced by stress (Figure 2). Defects are generally described as small, medium, or large, and as mild, moderate, or severe.¹⁰

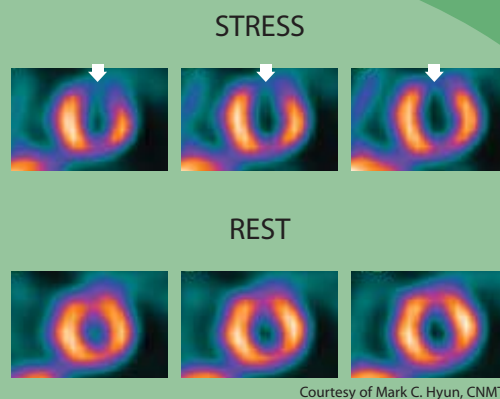


Figure 2. SPECT images showing a severe, reversible anterior perfusion defect (arrows).
Courtesy of Mark C. Hyun, CNMT.

SUMMARY

Great variability exists in the acquisition, processing, and interpretation of myocardial perfusion images with SPECT. Different nuclear labs use different protocols and software in the utilization of SPECT for assessing patients for CAD. However, nuclear technologists and nurses should be familiar with the basic principles and parameters that are similar across these varying protocols.

References

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