Continuing Medical Education Article

An Evidence-Based Review of Quantitative SPECT Imaging and Potential Clinical Applications

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Disclosure

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Target Audience

This article contains information of value to practitioners in nuclear medicine—in particular, medical physicists, technologists, and advanced trainees/registrars/residents.

Objectives

On successful completion of this activity, participants should be able to…
1. Review the current status of SPECT imaging, with an emphasis on clinical applications for quantitative interpretations.

2. Consider the requirements for quantitative SPECT imaging—instrumentation, software, and image calibration.

3. Acquire knowledge of the capabilities of quantitative SPECT with a view to developing new clinical applications.

Questions

1. Why has SPECT traditionally been regarded as nonquantitative?
   A. There are few potential applications for quantitative SPECT.
   B. Attenuation correction is more challenging in SPECT than in PET.
   C. Coincidence detection of dual-annihilation photons is needed to perform attenuation and scatter correction.
   D. It is not possible to make a SPECT reconstruction quantitative.

2. Scattered photons typically contribute how much to the SPECT signal in $^{99m}$Tc imaging?
   A. 5%.
   B. 10%.
   C. 20%.
   D. 30% or more.

3. What is the magnitude of scattered photons recorded in SPECT compared with 3-dimensional PET systems?
   A. Much lower for PET than SPECT.
   B. On the same order for PET as for SPECT.
C. Much higher for PET than SPECT.
D. A much greater problem in SPECT than PET because time of flight has eliminated scattered events.

4. What is the reconstruction algorithm of choice for SPECT?
   A. Filtered backprojection.
   B. Time-of-flight reconstruction.
   C. An iterative algorithm such as ordered-subsets expectation maximization.
   D. The Chang algorithm.

5. What is the main aim of a quantitative SPECT reconstruction?
   A. Removal of artifacts in reconstructed images.
   B. Correction for inferior wall attenuation in myocardial perfusion imaging.
   C. Production of SPECT images in standardized uptake value units.
   D. Production of images in units of radioactivity per unit volume.

6. For what are combined SPECT and CT hybrid scanners useful?
   A. They enable quantitative SPECT to be more easily achieved than on a SPECT-only system.
   B. They are of no benefit for quantitative SPECT.
   C. They are useful purely for multimodality image review.
   D. They are useful only for attenuation correction for $^{99m}$Tc radiopharmaceuticals.

7. What is the accuracy of SPECT reconstructions for $^{99m}$Tc-labeled tracers clinically?
   A. Within better than 10% of the true value.
B. Around 20% accurate.
C. Accurate to within approximately 50% of the true value.
D. Not defined—SPECT accuracy has not been demonstrated in clinical studies to date.

8. What is the quantitative capability of SPECT today compared with PET for relatively large objects (or structures)?
A. Inferior.
B. Comparable.
C. Superior.
D. Not comparable because the sensitivity and spatial resolution are so different between the 2 modalities.

9. For what sized objects does partial-volume effect compromise SUVs in emission tomography (PET and SPECT)?
A. For objects less than the system spatial resolution (full width at half maximum [FWHM]).
B. For objects approximately twice the system spatial resolution (FWHM).
C. For objects less than approximately 3 times the system spatial resolution (FWHM).
D. Approximately the same size for SPECT and PET.

10. What is the evidence that quantitative SPECT can be done clinically?
A. Evidence does not exist.
B. Evidence is lacking; however, validations in phantoms have been published.
C. Evidence has shown it to be accurate in terms of reconstructed radioactivity concentrations using $^{99m}$Tc-labeled radiopharmaceuticals.
D. Evidence has shown it to be accurate in terms of reconstructed radioactivity concentrations for a wide range of single-photon–emitting radionuclides.