



SPECT

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Single-photon emission computed tomography (SPECT) differs from other types of tomographic, radiologic imaging such as CT or conventional radiography. Rather than passing x-rays through a patient to form an image, the patient is injected with a radiopharmaceutical and the patient emits radiation in the form of gamma rays or x-rays, which are detected by a gamma camera. Multiple views of the patient are acquired and subsequently reconstructed into a series of slices through the patient to provide a 3D representation of the in vivo radiopharmaceutical distribution.^{1,2,3,4}

Although most SPECT imaging protocols have been optimized over time, it is worthwhile to be aware of aspects that can affect patient dose and image quality, keeping in mind that the notion of optimal image quality is task specific and thus must be considered for each protocol. As with planar imaging, opportunities for radiation dose reduction for the patient can be related to how efficiently the radiation emitted from the patient is used to form an image. If a higher fraction of emitted radiation can be used to form a good image, then the administered dose can be lowered. Most modern rotating gamma camera SPECT systems consist of two camera heads to provide higher counting efficiency. Recently, dedicated SPECT systems with even higher sensitivity have been developed for cardiac SPECT (see [Appropriate Use of Effective Dose and Organ Dose in Nuclear Medicine](#)). A gamma camera must use a collimator to form a useful image, but the collimator is inherently inefficient in that most of the photons emitted from the patient and striking the camera face are absorbed in the septa. A tradeoff exists when selecting the most appropriate collimator between spatial resolution and efficiency, and this may be different for SPECT than for planar imaging. Whereas a general purpose collimator may be appropriate for a clinical planar imaging application, a high-resolution collimator may be preferable for the associated SPECT application. In addition, with SPECT, how the collimator performs at a greater distance from the collimator face (e.g. at 15 cm) may be more important than at closer distances. Specialized collimators may be used for specific imaging tasks, such as fan beam collimators for brain imaging. SPECT image quality also can be optimized by proper camera set-up and patient positioning noting that spatial resolution is best when the patient is as close to the collimator face as possible.⁵

Image noise also affects the overall image quality, and using more photons to form the image lowers the noise and improves image quality. This relates to imaging time as well as camera efficiency. For a certain desired noise level and camera configuration, imaging longer will give more counts per unit administered dose to the patient. However, imaging time is limited by a patient's ability to remain still, and thus most SPECT protocols are limited to 20-30 minutes total duration. In some situations, such as for a larger patient, increasing imaging time per view



in a SPECT acquisition could be preferable to increasing the administered activity, if it can be tolerated by the patient.

For a few types of studies where a choice of radionuclide is available, the choice of radionuclide may affect the patient radiation dose. For example, for cardiac SPECT studies, where ^{201}Tl or $^{99\text{m}}\text{Tc}$ may be used, ^{201}Tl delivers a much higher radiation dose per study than for a $^{99\text{m}}\text{Tc}$ study even though the amount of activity administered is lower. Care should be taken to select the appropriate protocol and radionuclide to fit the situation.

The reconstruction method used will also affect image quality. Most SPECT system manufacturers now offer iterative reconstruction methods that provide features such as resolution recovery, scatter and other corrections. These features may lead to sufficiently improved image quality to allow for a lower administered activity compared to traditional reconstruction algorithms such as filtered backprojection.^{6,7,8} However, this may depend on the specific clinical imaging task.

Optimizing the SPECT acquisition to achieve the best spatial resolution and image noise for a particular clinical task involves selecting the proper instrumentation and reconstruction technique and performing the study properly. This assures the most efficient use of the administered activity and, therefore, provides the best opportunity for radiation dose optimization.

References

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