

Identifying and Avoiding Artifacts in SPECT Myocardial Perfusion Imaging

Myocardial perfusion imaging with single-photon emission computed tomography (SPECT) is a proven noninvasive technique for diagnosing coronary artery disease (CAD).¹ Technical and patient-related issues that arise during SPECT imaging can cause artifacts, which may lead to false-positive scan results that reduce diagnostic accuracy.² With the development and validation of hardware and software tools, we are making steady progress toward simplifying the correction of common artifacts.³⁻⁵ Nevertheless, anticipating, recognizing, and avoiding artifacts in SPECT imaging will improve accuracy and may prevent the need for retesting.²

CAMERA-RELATED ISSUES

Low SPECT image resolution and the appearance of artifacts may be caused by problems with the gamma camera itself. Poor alignment of detectors and center of rotation errors can lead to blurred SPECT images.² Large distances between the radiotracer source and the collimator caused by improper positioning of the camera or the patient's body habitus can also occur. If available, resolution recovery hardware and software may correct for some of these issues during image reconstruction, though periodic examination and recalibration of the SPECT gamma camera, as suggested by The Intersocietal Commission for the Accreditation of Nuclear Medicine Laboratories (ICANL), can reduce the frequency of these imaging artifacts (Table).^{1,6}

TRACER UPTAKE ISSUES

The Tc-99m-labeled SPECT radionuclide tracers can become concentrated in subdiaphragmatic tissues, causing increased counts in the inferior wall that can mask true perfusion defects. This may also be misinterpreted as reduced uptake in the surrounding myocardium (Figure 1).^{2,7} While there are no reliable methods for correcting artifacts caused by noncardiac radionuclide uptake, optimization of protocol timing to allow adequate tracer clearance can improve image quality. Tracer clearance may also be facilitated by filling the stomach with cold water prior to the scan.⁸ Adding patient movement during tracer administration can also improve noncardiac tracer clearance.⁹

PATIENT MOTION

Motion during acquisition of SPECT data is one of the most common causes of SPECT imaging artifacts,¹⁰ and is a major source of false-positive results and decreased test specificity (Figure 2).¹¹ Patient motion during the scan places the heart at different locations during image acquisition, causing blurring. Patient motion can usually be detected on rotating cine displays or static sinograms.^{3,12}

Re-imaging the patient after movement may be necessary in order to produce accurate SPECT images. If re-imaging is not an option, many systems include a motion correction

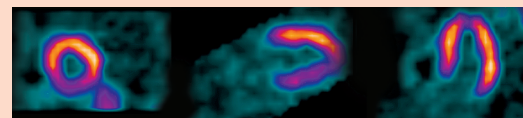
Table. ICANL Equipment Quality Control Protocols for Scintillation Cameras⁶

TEST	FREQUENCY
Energy peaking	Daily (prior to use; documentation not required)
Intrinsic or extrinsic uniformity (approximately 2-5 million counts)	Daily (prior to use)
Resolution and linearity	Weekly
High-count calibration floods (>30 million counts)	Monthly, or per manufacturer's recommendations
Center of rotation (SPECT)	Monthly
Collimator integrity	Annually
Uniformity calibration	Per manufacturer's recommendations
Preventive maintenance	Every 6 months, or per manufacturer's recommendations

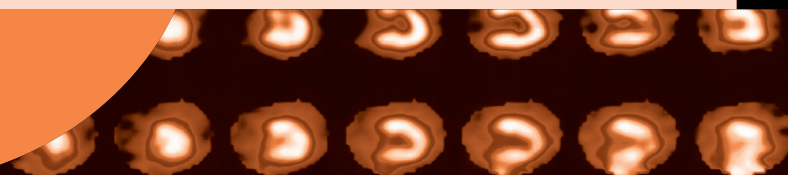
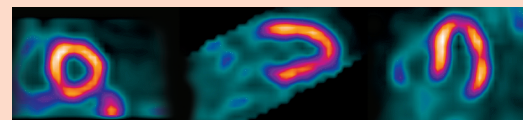
Adapted from the ICANL *Essentials and Standards for Nuclear Cardiology Accreditation*, 2003.

Figure 1. Subdiaphragmatic uptake of SPECT radiotracer.

No attenuation correction



Attenuation correction



software program that can be used during image reconstruction.^{1,3} If motion correction algorithms are used, both the corrected and uncorrected images should be provided to the reading physician.

Adequate preparation of the patient prior to the test may help reduce the likelihood of motion artifacts. Imaging procedures should be explained to the patient and the patient should be encouraged not to talk, yawn, sigh, or sleep during the scan. Supporting the left or both arms above the patient's head may improve patient comfort and thus reduce motion.

ATTENUATION

Reconstruction of radionuclide tracer distribution in the myocardium depends on the accurate detection of emitted photons by the SPECT camera.¹⁰ As photons emitted from the radionuclide tracer move through the body, differences in tissue density surrounding the heart may lead to absorption or redirection (scatter) of photons.¹⁰ In certain patients, the emission signal that reaches the SPECT detectors may be significantly decreased, or attenuated, leading to poor image quality and reduced specificity.¹³

Attenuation artifacts are common in obese patients and patients with large chest circumferences, as well as in large-breasted women (Figure 3).² Breast attenuation can lead to artifacts that appear as anterior, lateral, or apical defects, while diaphragmatic attenuation can lead to apparent inferior wall defects.^{5,10} Artifacts that appear on both rest and stress images may be misinterpreted as fixed defects.⁵ Supplemental prone imaging can help identify inferior wall attenuation artifacts.^{14,15} To reduce variable breast attenuation, both the stress and rest images should be acquired either with the bra on or the bra off.¹⁶

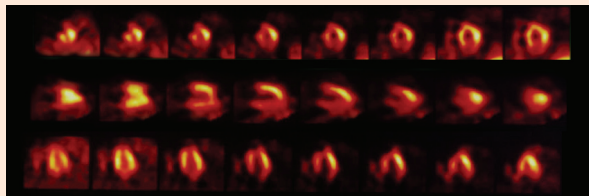
New hardware and software are continually being developed and implemented in order to permit attenuation correction during reconstruction of SPECT images.^{5,17-19} If these systems are available, both attenuation-corrected and uncorrected images should be provided to the reading physician.²⁰

SUMMARY

Several technical- and patient-related issues may arise during SPECT imaging that can result in imaging artifacts and false-positive scan results, thus reducing diagnostic specificity. Quality control measures, such as periodic testing and recalibration of the gamma camera; anticipation and identification of common sources of SPECT imaging artifacts due to patient movement or body habitus; and implementation of new hardware and software to correct for various types of artifacts may reduce the likelihood of artifacts and help improve SPECT diagnostic accuracy in the future.

Figure 2. Patient movement during a SPECT scan.

Uncorrected



Corrected

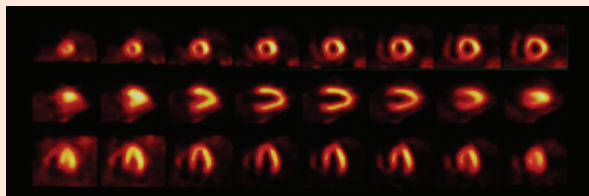
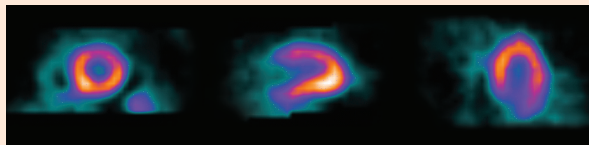
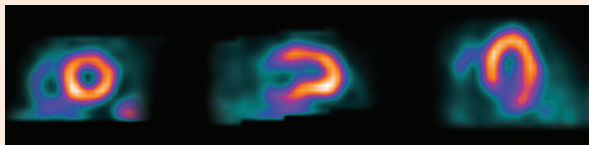


Figure 3. Breast attenuation can reduce image resolution.

No attenuation correction



Attenuation correction



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