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Using X-ray CT for Attenuation Correction

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Soft-tissue attenuation limits the diagnostic accuracy, interpretive confidence, quantitation, and laboratory efficiency of myocardial perfusion SPECT imaging (1). Attenuation artefacts reduce SPECT specificity, as artefacts can be misinterpreted as perfusion defects. Attenuation artefacts may also reduce SPECT sensitivity when images are improperly scaled to regions suppressed by attenuation, potentially masking true perfusion defects. Attenuation correction (AC) SPECT systems use transmission based imaging with external radionuclide or x-ray sources to measure patient anatomy and iterative algorithms to correct the emission images (2). Although AC has been shown to improve the specificity of SPECT imaging (3), it has been only partially adapted in practice for several reasons, including a lack of robust algorithms for standardized application, varied hardware approaches, and an interpretive bias toward noncorrected SPECT imaging.

Published studies and guidelines have highlighted the importance of high-quality attenuation maps and proper implementation of the systems to minimize errors in attenuation-corrected images(1). A common problem of external radionuclide-based AC systems is the low activity of the radioactive sources leading either to long acquisition times or to attenuation maps with low counting rates, causing poor quality. Moreover, if the energy of the transmission photons is lower than that of the emission radionuclide, there is also cross talk of the attenuation map. Systems with higher photon flux that generate high-quality attenuation maps yield the best results (4), and x-ray tomography (CT) maps seem to be most promising. Other advantages of the CT method include lower noise and improved resolution.

Hybrid SPECT/CT systems represent the state of the art for AC. However, they suffer from the potential for misregistration of emission and transmission scans because CT and SPECT are obtained sequentially. Possible sources of misregistration include respiratory motion, voluntary patient movement or mechanical misalignment of the SPECT/CT system (5). Phantom and human studies have shown that misregistration can produce errors in the activity distribution of attenuation-corrected perfusion images, thus reducing the diagnostic accuracy of myocardial perfusion SPECT. Therefore visual alignment of SPECT/CT fusion images is important, and software tools for reregistration of misaligned studies may be a useful tool for correction.

References

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