TECH TIPS

astellas

TECHNICALLY SPEAKING

EDUCATIONAL TOPICS FOR NUCLEAR LAB PROFESSIONALS

Technical Advances in SPECT Myocardial Perfusion Imaging

INTRODUCTION

Looking back on 4 decades of nuclear cardiology, it is remarkable how far the field and single-photon emission computed tomography (SPECT) myocardial perfusion imaging (MPI) technology has come. Today, more than 6 million SPECT MPI scans are performed each year,[1] and SPECT is accepted as a powerful modality for assessing cardiac perfusion and function to diagnose coronary artery disease, assess risk, and guide management decisions. The field continues to evolve, with exciting advances in SPECT MPI technology—hardware, software, protocols, and new applications—that focus on improving lab efficiency, reducing radiation exposure, increasing patient comfort, and improving image quality (Table 1).

REDUCING RADIATION EXPOSURE

Cardiac imaging procedures, including cardiac CT, and radionuclide imaging, expose patients to small amounts of ionizing radiation.[9] In the US, the prevalence of and mortality associated with risk factors for coronary heart disease, particularly obesity and diabetes, continue to increase and these risk factors are manifesting at earlier ages.[10] Coupled with a general increase in life expectancy,[11] the number of imaging procedures a person will undergo during his or her lifetime is expected to rise.[9] Responding to growing concern about cumulative radiation exposure from imaging procedures, cardiac imaging techniques and appropriate patient selection algorithms are being implemented that strive to limit individual patient radiation exposure while still maintaining image quality.[3] Strategies to reduce patient radiation exposure in SPECT MPI include reducing tracer dose and using resolution recovery software to maintain image quality with lower-count image acquisitions.[9] New SPECT cameras and imaging techniques that require less radiotracer may also help labs meet the challenges posed by periodic radiotracer shortages.

IMPROVING PATIENT COMFORT

Improving the patient's experience during a SPECT MPI scan can impact image quality by reducing patient motion and the potential for motion artifacts.[2] New camera designs allow patients to be imaged upright or reclining, with no need to raise their arms as required during supine imaging.[2]

Table 1. Technological advances in SPECT MPI.[2-8]

HARDWARE	SOFTWARE
■ Cardius® 3 XPO (Digirad) ■ CardiArc® (CardiArc) ■ D-SPECT™ (Spectrum Dynamics) ■ Ultrafast Cardiac Camera with Alcyone™ technology (GE) ■ IQ SPECT™ (Siemens) ■ BrightView XCT (Philips)	■ nSPEED® (Digirad) ■ Astonish™ (Philips) ■ Evolution for Cardiac™ (GE) ■ Flash 3D™ (Siemens) ■ Wide Beam Reconstruction™ (WBR; UltraSpect)

PROTOCOLS
■ Stress only + attenuation correction ■ Very early poststress imaging ■ Rapid dual-isotope

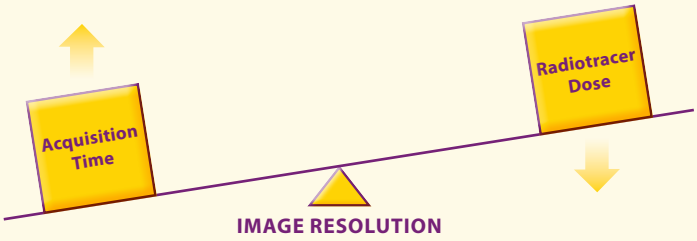
NOTE: None of the above is a registered trademark of Astellas Pharma US, Inc. Registered trademarks are the property of their respective owners.

New SPECT cameras have been developed that have cut MPI image acquisition to one-half and even one-quarter the standard time (15-20 minutes for each stress and rest acquisition).[2] In addition to the potential benefits of fast SPECT on lab throughput and scheduling, reducing acquisition time also increases patient compliance and comfort, thus decreasing motion artifacts.[2] These cameras have optimized acquisition geometry, new detector materials, and collimator designs that allow better sampling of myocardium and higher spatial resolution and sensitivity at greatly reduced acquisition times.[2] Because the new SPECT cameras detect a higher number of counts specifically from the myocardium, it is possible to preserve or improve image quality, despite shorter imaging times.[2]

MAINTAINING IMAGE QUALITY

SPECT MPI protocols that either use less radiotracer or reduce image acquisition time produce fewer detected counts. In an effort to overcome the well-known tradeoff between sensitivity and resolution, new reconstruction software has been developed to improve image contrast and reduce noise levels inherent in low-count images, correcting for scatter and attenuation and preserving image resolution (Figure 1).[2]

Figure 1. With the overall goal of reducing radiation exposure, new SPECT MPI protocols make it possible to reduce either image acquisition time or the radiotracer dose.



NEW SPECT MPI PROTOCOLS

Several new SPECT protocols are being developed to reduce scan time, optimize SPECT utilization, and potentially improve patient compliance and lab efficiency. For patients with low pretest risk or who can exercise, stress-only imaging with attenuation correction may be sufficient to rule out disease.[3,5,12] ASNC released a clinical update in 2009 approving the use of stress-only imaging protocols in certain patients, who would undergo a rest test only if there is an abnormality on the stress images, or if other risk factors (eg, clinical risk factors, abnormal ECG) suggest the potential for coronary heart disease.[13] To ensure accuracy, stress-only studies are carried out with or without attenuation correction.[13] Stress-only imaging has the potential to reduce patient and staff radiation exposure, unnecessary rest scans, and time and healthcare costs.[3,13,14]

Protocols that acquire images very early after stress administration, prior to liver and bowel uptake, are also being evaluated.[6] In preliminary studies, SPECT MPI images acquired less than 6 minutes after radiotracer injection showed equivalent subdiaphragmatic activity and degree of patient motion, as well as similar perfusion defect scores and left ventricular ejection fraction (LVEF) measurements, compared with images acquired at standard acquisition times.[6] Application of scatter correction methods during image reconstruction may improve early post-stress image interpretation by separating myocardial and gut activity.[15] Another new protocol that may be possible using new SPECT (collimator) materials in high-speed MPI scanners is a rapid dual-isotope protocol, with stress-rest images acquired in less than 20 minutes.[7]

Visit **pharmstresstech.com** for *Tech Tips* podcasts and interactive modules, which include an educational question-and-answer section.

IAC NUCLEAR/PET ACCREDITATION[16]

Recognizing the potential impact of the recent technological advances in SPECT MPI on patient care, the Intersocietal Accreditation Commission (IAC) Nuclear/PET developed a set of provisions that must be met by laboratories that utilize new SPECT technology or parameters outside of the currently accepted IAC Nuclear/PET Standards. Laboratories must demonstrate clinical validation of the new technologies, showing that they can produce clinical results that are reproducible and equal to or better than currently accepted technologies, based on published, peer-reviewed data.

Laboratories that use standard imaging equipment with new imaging reconstruction software, or that use new hardware technology not incorporated into published imaging guidelines, are required to (1) perform simulator studies using their laboratory's actual imaging parameters to demonstrate defect reproducibility, (2) demonstrate adherence to manufacturers' QC specifications, document training, and clinical competency by technical staff.

CONCLUSION

The field of nuclear cardiology is experiencing an extraordinary period of innovation and technological advance, from new cameras with novel detector materials and detector array geometries that allow image acquisition in a fraction of the time needed with standard cameras; to new reconstruction software that can maintain image resolution with low-count data acquisition; to new, faster SPECT MPI protocols. These advances hold the potential to increase patient comfort and compliance, reduce radiation exposure to the patient and staff, and improve lab efficiency.

References

1. AMR data on file. 2011. **2.** Slomka PJ, Patton JA, Berman DS, Germano G. Advances in technical aspects of myocardial perfusion SPECT imaging. *J Nucl Cardiol*. 2009;16:255-276. **3.** DePuey EG. Advances in SPECT camera software and hardware: currently available and new on the horizon [published ahead of print March 29, 2012]. *J Nucl Cardiol*. doi: 10.1007/s12350-012-9544-7. **4.** Forrest W. Hardware, software advances spark cardiac SPECT progress. http://www.auntminnie.com/index.aspx?sec=sup_n&sub=mol&pag=dis&ItemID=94395. Accessed May 3, 2012. **5.** Gibson PB, Demus D, Noto R, et al. Low event rate for stress-only perfusion imaging in patients evaluated for chest pain. *J Am Coll Cardiol*. 2002;39:999-1004. **6.** Cullom S, Hsu BL, Case J, Volker L, Phillips R, Bateman T. Very early post-stress (<6min) myocardial perfusion SPECT with Tc-99M-tetrofosmin. *J Nucl Med*. 2008;49:126P. Presented at: Society of Nuclear Medicine Annual Meeting; June 14-18, 2008; New Orleans, LA. Abstract 503. **7.** Berman DS, Kang X, Tamarappoo B, et al. Stress thallium-201/rest technetium-99m sequential dual isotope high-speed myocardial perfusion imaging. *JACC Cardiovasc Imaging*. 2009;2:273-282. **8.** Garcia EV, Faber TL, Esteves FP. Cardiac dedicated ultrafast SPECT cameras: new designs and clinical implications. *J Nucl Med*. 2011;52:210-217. **9.** Ficaro EP, Zanzonico P, Stabin MG, et al. Variability in radiation dose estimates from nuclear and computed tomography diagnostic imaging. http://www.asnc.org/imageuploads/InformationStatementRadiationDosimetry2009.pdf. Accessed May 3, 2012. **10.** Roger VL, Go AS, Lloyd-Jones DM, et al. Heart disease and stroke statistics—2011 update: a report from the American Heart Association. *Circulation*. 2011;123:e18-e209. **11.** Arias E. National Vital Statistics Report. US Department of Health & Human Services. 2011;59:1-60. **12.** Heller GV, Bateman TM, Johnson JL. Clinical value of attenuation correction in stress-only Tc-99m sestamibi SPECT imaging. *J Nucl Cardiol*. 2004;11:273-281. **13.** Des Prez RD, Dahlberg ST, Einstein AJ, et al. ASNC clinical update: stress-only myocardial perfusion imaging. http://www.asnc.org/imageuploads/ClinicalUpdateStressOnlyMPI2009.pdf. Accessed May 3, 2012. **14.** Chang SM, Nabi F, Xu J, Raza U, Mahmarian JJ. Normal stress-only versus standard stress/rest myocardial perfusion imaging. *J Am Coll Cardiol*. 2010;55:221-230. **15.** Thompson RC. The problem of radiotracer abdominal activity in myocardial perfusion imaging studies. *J Nucl Cardiol*. 2008;15:159-161. **16.** IAC Web site. http://www.intersocietal.org/nuclear/standards/IAC_NuclearPET_Standards.pdf. Accessed July 26, 2012.

Provided as an educational service by Astellas Pharma US, Inc.

COMMITTED TO CARDIOLOGY®