Extra-cardiac findings in the age of hybrid cardiac imaging: Incidental or essential?

Firas J. Al Badarin, MD, MSc, FASNC^{a,b}

^a Heart and Vascular Institute (Swing Wing C08-260), Cleveland Clinic Abu Dhabi, Abu Dhabi, United Arab Emirates

^b Cleveland Clinic Lerner College of Medicine, Case Western Reserve University, Cleveland, OH

Received Mar 20, 2021; accepted Mar 22, 2021
doi:10.1007/s12350-021-02629-3

See related article, pp. 1813–1822

Increasing availability of hybrid imaging systems has led to a significant growth in their utilization in modern imaging laboratories. Incorporation of computed tomography (CT) with single photon emission computed tomography (SPECT) perfusion imaging for attenuation correction (AC) helps minimize soft tissue attenuation artifacts, thereby leading to improved image quality and diagnostic accuracy for perfusion studies.¹ Furthermore, hybrid systems allow concurrent evaluation of epicardial coronary vessels, complementing physiological assessment of myocardial perfusion with angiographic data.^{2,3} This helped expand hybrid imaging indications to a broader range of cardiovascular diseases with the goals of improving risk stratification and better guiding patient management.⁴

An additional key advantage of hybrid imaging is the enhanced diagnostic capability extending beyond the confines of the heart, thereby allowing detailed evaluation of extra-cardiac structures, including the lungs, thoracic aorta, and visualized portions of the alimentary tract. As more structures are included in a study's field-of-view, detection of 'incidental' extra-cardiac abnormalities on accompanying tomographic image sets becomes inevitably more frequent, creating the need to routinely review and report such findings. This has understandably moved to the forefront an ongoing

discussion about the prevalence of incidental CT findings in perfusion studies performed on hybrid imaging systems, their prognostic implications and impact on downstream resource utilization. Several groups have reported that incidental CT abnormalities are frequently encountered, most commonly in the lungs,^{5–10} and that these lesions are associated with cancer-specific mortality and poor mid-term outcomes.^{11,12}

Adding to existing evidence, Lee and colleagues in this issue of the *Journal* report the prevalence of incidentally detected lesions (IDL) on low-dose CT performed for AC during SPECT myocardial perfusion imaging (MPI). The authors retrospectively reviewed reports for all MPI studies performed at a single center in Australia between 2012 and 2016. Cardiac (cardiomegaly, pericardial effusion) and non-cardiac (pathologies of the thoracic aorta, lungs, liver, spleen, retroperitoneum, etc.) abnormalities were considered IDL, and lesions not known prior to the time of MPI performance or those which significantly progressed were considered "IDL of potential clinical significance". Further investigations post-MPI, including additional imaging and biopsies, were ascertained through review of medical records on all patients for up to 12 months. In their sample of 3,758 patients who underwent MPI, an IDL of any level of significance was found in 2,745 (73%) studies, of which 245 (8.9%) were deemed "IDL of potential clinical significance". The lungs were the most common location for potentially significant lesions, followed by the liver and the kidneys. Thirty lesions (12.2% of potentially significant IDL) were proven to require further treatment or intervention, including 12 cases of primary lung malignancy and 2 cases of lung metastases.

The large sample size in this study and the completeness of follow-up on patients with and without incidentally detected lesions are notable strengths for which the authors are to be congratulated. The current

Reprint requests: Firas J. Al Badarin, MD, MSc, FASNC, Heart and Vascular Institute (Swing Wing C08-260), Cleveland Clinic Abu Dhabi, Al Maryah Island, PO Box 112412 Abu Dhabi, United Arab Emirates; albadarin@gmail.com

J Nucl Cardiol 2022;29:1823–5.

1071-3581/\$34.00

Copyright © 2021 American Society of Nuclear Cardiology.

Figure. Information obtained from a perfusion study performed on a SPECT/CT system to evaluate patients with chest pain or other symptoms suggestive of epicardial coronary disease.

findings are also in line with prior similar investigations despite the apparent difference in IDL frequencies across studies, ranging from 12% to 73% for IDL of any significance and 2%-33% for potentially significant IDL. The observed difference is multifactorial but may likely be related to variation in underlying IDL definition, such that studies with broader definitions, including the one used by Lee et al., will predictably yield a greater number of detected CT abnormalities.

At the same time, the broad IDL definition adopted by the investigators may potentially be problematic. Firstly, using an all-encompassing IDL definition will artificially lower reported positive predictive value for IDL, as seen in this study. Additionally, non-perfusion cardiac abnormalities (pericardial effusion or cardiomegaly) which were considered as IDL by the authors, are not conventionally thought of as incidental CT findings, but are rather essential components of a well-interpreted SPECT MPI study, especially when done with a hybrid SPECT/CT system. This is more congruent with the contemporary view of MPI as a versatile tool for evaluation of cardiac form and function. In fact, when performed in conjunction with CT, an MPI study will not only provide reliable information on the presence and magnitude of myocardial ischemia, but also can provide incremental diagnostic and prognostic information that can inform further patient management (Figure). Therefore, a comprehensive MPI report must include description of abnormalities in myocardial perfusion, cardiac size, and ventricular systolic function, in addition to documenting the presence and extent of coronary atherosclerosis, pericardial effusion or other pericardial pathology, thoracic aortic atheroma, and any obvious abnormalities in the lungs or other GI organs included in the field-of-view of the study.¹³

In patients undergoing coronary CT angiography or radionuclide perfusion imaging using hybrid imaging systems, the preponderance of available evidence confirms that extra-cardiac findings are commonly encountered and deserve needed attention. Instead of fueling further debate about the relevance of such lesions, the focus should be on creating and disseminating educational resources and reporting guidelines to interpreting physicians to guide with identification and reporting of these abnormalities. The growing emphasis on the value of imaging will only result in greater demands to maximize the diagnostic yield of an imaging study.¹⁴ This can be accomplished with systematic review of all available data elements and subsequently providing referring physicians with comprehensive report blending cardiac and critical extra-cardiac findings to best assess patients' risk and guide their management. To this extent, it is safe to say that in the current era, extra-cardiac findings on CT need no longer be considered incidental, but rather essential elements of perfusion imaging with hybrid systems.

Disclosures

The authors report no relevant financial disclosures.

References

1. Masood Y, Liu Y-H, DePuey G, Taillefer R, Araujo LI, Allen S, et al. Clinical validation of SPECT attenuation correction using x-ray computed tomography-derived attenuation maps: Multicenter clinical trial with angiographic correlation. *J Nucl Cardiol*. 2005;12(6):676-86.
2. Kaufmann PA, Di Carli MF. Hybrid SPECT/CT and PET/CT imaging: the next step in noninvasive cardiac imaging. *Semin Nucl Med*. 2009;39(5):341-7.
3. Flotats A, Knuuti J, Gutberlet M, Bengel FM, Kaufmann PA, Rees MR, et al. Hybrid cardiac imaging: SPECT/CT and PET/CT. A joint position statement by the European Association of Nuclear Medicine (EANM), the European Society of Cardiac Radiology (ESCR) and the European Council of Nuclear Cardiology (ECNC). *Eur J Nucl Med Mol Imaging*. 2011;38(1):201-212.
4. Gaemperli O, Bengel FM, Kaufmann PA. Cardiac hybrid imaging. *Eur Heart J*. 2011;32(17):2100-8.
5. Karius P, Schuetz GM, Schlattmann P, Dewey M. Extracardiac findings on coronary CT angiography: a systematic review. *J Cardiovas Comput Tomogr*. 2014;8(3):174-182.e171-176.
6. He BJ, Malm BJ, Carino M, Sadeghi MM. Prevalence and variability in reporting of clinically actionable incidental findings on attenuation-correction CT scans in a veteran population. *J Nucl Cardiol*. 2019;26(5):1688-93.
7. Goldman LH, Lerer R, Shabrang C, Travin MI, Levsky JM. Clinical significance of incidental findings on coronary CT angiography: Insights from a randomized controlled trial. *J Nucl Cardiol*. 2020;27(6):2306-15.
8. Coward J, Lawson R, Kane T, Elias M, Howes A, Birchall J, et al. Multi-centre analysis of incidental findings on low-resolution CT

- attenuation correction images. *Br J Radiol.* 2014; 87(1042):20130701.
9. Goetze S, Pannu HK, Wahl RL. Clinically significant abnormal findings on the “nondiagnostic” CT portion of low-amperage-CT attenuation-corrected myocardial perfusion SPECT/CT studies. *J Nucl Med.* 2006;47(8):1312-8.
10. Husmann L, Tatsugami F, Aepli U, Herzog BA, Valenta I, Veit-Haibach P, et al. Prevalence of noncardiac findings on low dose 64-slice computed tomography used for attenuation correction in myocardial perfusion imaging with SPECT. *Int J Cardiovasc Imaging.* 2009;25(8):859-65.
11. Qureshi WT, Alirhayim Z, Khalid F, Al-Mallah MH. Prognostic value of extracardiac incidental findings on attenuation correction cardiac computed tomography. *J Nucl Cardiol.* 2016;23(6):1266-74.
12. Zadro C, Roussel N, Cassol E, Pascal P, Petermann A, Meyrignac O, et al. Prognostic impact of myocardial perfusion single photon emission computed tomography in patients with major extracardiac findings by computed tomography for attenuation correction. *J Nucl Cardiol.* 2018;25(5):1574-83.
13. Tilkemeier PL, Bourque J, Doukky R, Sanghani R, Weinberg RL. ASNC imaging guidelines for nuclear cardiology procedures : Standardized reporting of nuclear cardiology procedures. *J Nucl Cardiol.* 2017;24(6):2064-128.
14. Durand DJ, Lewin JS, Berkowitz SA. Medical-imaging stewardship in the accountable care era. *N Engl J Med.* 2015;373(18): 1691-3.

Publisher's Note Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.