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REPLY

We would like to thank Dr. Movahed for his interest in our paper (1), and welcome the opportunity to respond to his comments.

We agree that echocardiography is a valuable tool in the evaluation of patients who present with signs and symptoms suggestive of an acute coronary syndrome, a situation in which takotsubo cardiomyopathy is an important differential diagnosis. We also agree that there are several clinical and echocardiographic characteristics that are highly suggestive of the diagnosis of takotsubo cardiomyopathy. There are specific situations where the presentation is compelling enough that coronary angiography may be reasonably deferred in the presence of significant comorbidities that would increase the risk of cardiac catheterization. However, the pattern of regional wall motion abnormality of the left ventricle in many patients with an acute coronary syndrome, especially when due to ischemia in the left anterior descending coronary artery territory, can mimic takotsubo cardiomyopathy. Moreover, in occasional patients with takotsubo cardiomyopathy, the pattern of regional wall motion abnormality may not involve multiple coronary distributions. Thus, given the typically low risk of performing coronary angiography in most patients and the potential adverse consequences of an incorrect diagnosis with respect to an acute coronary syndrome, we advocate that urgent or emergent coronary angiography be performed in the absence of absolute contraindications, to exclude occlusive coronary artery disease. Indeed, takotsubo cardiomyopathy can, in rare circumstances, coexist with occlusive coronary artery disease, as highlighted in the modified Mayo Clinic diagnostic criteria (2). Ultimately, clinical judgment is required to differentiate takotsubo cardiomyopathy from other etiologies of acute coronary syndrome.

R. Todd Hurst, MD,* Abhiram Prasad, MD, J. Wells Askew III, MD, Partho P. Sengupta, MBBS, A. Jamil Tajik, MD

*Mayo Clinic, Cardiovascular Diseases, 13400 E. Shea Boulevard, Scottsdale, Arizona 85259. *E-mail:* hurst.todd@mayo.edu

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Radiation Exposure From Cardiac Computed Tomography

We read with interest the article by Ho et al. (1) in the recent edition of *ijACC*. Computed tomography (CT) myocardial perfusion imaging (MPI) offers a new, noninvasive functional assessment of myocardial ischemia. When combined with CT coronary angiography, it may offer the strong negative predictive value of an anatomical test and the specificity of functional testing in a “1-stop shop.”

CT MPI accuracy and radiation dose has been compared with nuclear MPI as a reference.

The effective radiation dose from a medical exposure is measured in mSv. This value takes into account the different radiation sources and the potential biological harm from exposure to a particular organ. Tissues with a high susceptibility to harm from ionizing radiation are allocated a higher weighting in the calculation of effective dose—a higher tissue weighting factor. In 2007, the International Commission on Radiological Protection (ICRP) updated the tissue weighting factors in light of further epidemiological studies; of importance is the increase in the breast-tissue weighting factor from 0.05 to 0.12 (2).

There is now increasing evidence that previously published chest conversion factors (when applied to cardiac CT) significantly underestimate the effective dose to the patient. This is due to 2 factors: 1) the change in the ICRP tissue weighting factors mentioned earlier; and 2) the marked difference in scan volume between cardiac and whole-chest CT scans. Cardiac CT scans only irradiate the lower chest and upper abdomen, a scan field that involves irradiating the breast tissue for the majority of the scan volume, rather than including the relatively radio-insensitive tissues of the upper chest.

Work in our institution (3) using computer-based anthropomorphic phantoms has demonstrated that the conversion factor for cardiac CT is at least double that previously reported; this has been confirmed by other groups (4-6).

We suggest a conversion factor of 0.028 (3) for prospectively gated cardiac CT—which would result in a doubling of the reported dose to 36.5 mSv for the stress and rest examination in the paper by Ho et al. (1). With increasing evidence of the risk of ionizing radiation from medical exposure (7), further dose reduction strategies will be needed before CT MPI becomes the primary choice for functional imaging over established techniques such as stress echocardiography and cardiac magnetic resonance.

Oliver E. Gosling, BM,* Carl A. Roobottom, MB

*C/O Professor Roobottoms' Office, Department of Radiology, Plymouth Hospitals NHS Trust, Derriford Hospital, Derriford Road, Plymouth PL6 8DH, United Kingdom. *E-mail:* Oliver.gosling@pms.ac.uk

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REPLY

We thank Gosling and Roobottom for their interest in our paper (1), and we agree that, following the ALARA (as low as reasonably achievable) principle, further research in computed tomography (CT) myocardial perfusion imaging (MPI) should include efforts at dose reduction. We are aware of the growing number of studies refining the calculation of effective dose, but we do not agree that as a consequence of recalculated conversion factors, “further dose reduction strategies will be needed before CT MPI becomes the primary choice for functional imaging.”

This conclusion is based on the implicit assumption that the risk associated with CT MPI as reported by us is twice as high as in single-photon emission computed tomography (SPECT), and that this difference is significant. As carefully detailed in Martin’s (2) review of the use of effective dose, the estimated risk of cancer may be a factor of 3 higher or lower when applied to a reference patient. Martin (2) therefore suggests describing risk using broad categories spanning a factor of 10 in effective dose. McCollough et al. (3) in a recent review paper share this interpretation. They conclude that “effective dose should not be used for epidemiologic studies or for estimating population risks,” and they state that “with such uncertainties, it is clear that the current emphasis on calculating and reporting effective dose is not merited.”

Even if one were to approximately assess risk based on effective dose calculations, a little more refinement might be necessary in calculating the conversion factors. In comparison to coronary computed tomography angiography (CTA), significantly less breast tissue is exposed in CT MPI with a scan range of less than 8 cm above the diaphragm.

Moreover, Deak et al. (4) in a very recent paper strongly advocate sex- and age-specific conversion factors. They suggest significantly higher chest conversion factors for the average adult reference woman, but their factor for adult men is actually lower than the one we used. Last, patients undergoing stress perfusion imaging tend to be those at higher risk of coronary artery disease, i.e., older, and post-menopausal if female. For women, the risk factor for breast exposure decreases by a factor of 2 to 3 between ages 30 and 50 (5).

If one would correct the organ weighting factor for the fraction of breast tissue actually exposed to radiation during CT MPI, and use age- and sex-specific conversion factors that reflect the demographics of perfusion imaging patients, then there might be little difference in “procedure effective dose” from what was calculated with the original conversion factor.

This, however, was not the scope of our paper (1). Our study evaluated the feasibility of CT MPI and validated it in comparison with nuclear MPI. We did not assess the exact utility of CT MPI as part of a comprehensive cardiac CT examination. For instance, as discussed by ourselves and others (6), dynamic CT MPI at rest might be replaced with parenchymal information obtained during the coronary CTA study. Such protocols would directly halve the dose.

Considering all these factors, we believe that the conclusion of our paper, that CT MPI provides comparable diagnostic information to SPECT at comparable dose levels, is justified.

Kheng-Thye Ho, DCBCCT, DCBNC,* Kia-Chong Chua, MSc, Ernst Klotz, MSc, Christoph Panknin, MSc

*Heart Consultants Pte Ltd, Mount Alvernia Hospital, 820 Thomson Road, #02-25A, Medical Centre Block A, Singapore 574623. *E-mail: DrHoKT@me.com*

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Mr. Klotz and Mr. Panknin are employees of Siemens Healthcare.

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