

# Assessment of left ventricular mass by SPECT MPI

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In this issue of the *Journal of Nuclear Cardiology*, A. Gimelli, R. Liga et al. report on left ventricular (LV) mass determination using two commercially available softwares that they applied to cadmium-zinc-telluride (CZT) single-photon emission computed tomography (SPECT) myocardial perfusion imaging (MPI), and compared results to cardiac magnetic resonance imaging (MRI) which was the reference standard.<sup>1</sup> For their study, they retrospectively identified  $n = 25$  patients who underwent MPI with gated <sup>99m</sup>Tc-tetrofosmin acquired on a CZT camera and had a cardiac MRI within  $12 \pm 3$  weeks. To put the authors' work on LV mass determination in perspective, we will address the importance, accepted methods, and nuclear imaging approaches to LV mass measurement.

A common cardiac adaptive mechanism in the setting of hemodynamic overload is the compensatory increase in LV mass, as explained by the Law of

LaPlace in which

$$\tau = \frac{P \times r}{2 \times T},$$

where  $\tau$  is the ventricular wall stress,  $P$  is the ventricular pressure,  $r$  is the ventricular radius, and  $T$  is the ventricular wall thickness.<sup>2</sup>

However, this compensatory increase in ventricular wall thickness is detrimental on the long run, as demonstrated by multiple clinical studies. Indeed, an increase in LV wall thickness or mass, typically due to left ventricular hypertrophy (LVH), predicts an increased risk of cardiovascular morbidity and mortality as determined in the Framingham Heart Study, even after adjustment for major risk factors.<sup>3</sup> Moreover, the severity of LVH is an independent predictor of death and coronary revascularization.<sup>4</sup> These early observations have been confirmed by more contemporary data where LV mass and LVH were found to be predictive of the need for future revascularization,<sup>5</sup> and of the occurrence of myocardial infarction and cardiac death<sup>6</sup> in patients with or without stress-inducible ischemia<sup>7</sup> or in the setting of asymptomatic aortic stenosis.<sup>8</sup> In patients with a previous myocardial infarction, prognosis is related to the percentage of viable LV mass, and LV mass measurement can assess the development of compensatory focal LVH.<sup>9</sup> Quantification of LV mass is also useful in the evaluation and management of patients with valvular heart disease and hypertrophic cardiomyopathy. Further, LV mass has been demonstrated to predict the incidence of congestive heart failure in the Multi-Ethnic Study of Atherosclerosis.<sup>10</sup> In addition, assessment of LV mass can be used to monitor response to therapies such as weight reduction<sup>11</sup> or kidney transplantation.<sup>12</sup>

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Previous work demonstrated the feasibility of using cardiac MRI to derive LV mass in vivo in animals, with excellent correlation to actual measured LV mass ex vivo.<sup>13,14</sup> Additional research optimized cardiac MRI methods for the quantification of LV mass in dogs, leading to high reproducibility and low standard error,<sup>15</sup> with similar results in humans demonstrated by excellent intra- and inter-observer variability.<sup>16</sup> Moreover, cardiac MRI permits modeling of the left ventricle free of geometric assumptions, without the physical limitations of ultrasound imaging, and with no ionizing radiation to the patient.<sup>17</sup> These observations have led cardiac MRI to become the reference standard for in vivo determination of LV mass<sup>18,19</sup> with additional robust data supporting its larger clinical use.<sup>20</sup> As indicated by the authors however, cardiac MRI, although the reference standard for LV mass measurement, has certain methodological limitations. In particular, the inclusion or exclusion of trabecular myocardium in global LV mass assessment has not been standardized.<sup>21</sup> In the present study,<sup>1</sup> the investigators manually traced the epi- and endocardial contours of the LV—excluding trabeculations—to determine myocardial volumes (myocardial volume = epicardial volume – endocardial volume). By multiplying myocardial volumes with the cardiac density ( $\rho = 1.05 \text{ g/mL}$ ), they obtained the LV mass. Reference values of cardiac MRI dimensions have been proposed.<sup>22</sup> The authors defined LVH according to cardiac MRI measurements based on previously reported and accepted parameters ( $> 74 \text{ g/m}^2$  in males and  $> 63 \text{ g/m}^2$  in females).<sup>23</sup>

Prior research using conventional Anger SPECT cameras demonstrated that LV mass can also be computed from radionuclide MPI studies.<sup>24,25</sup> Subsequently, this approach was validated against cardiac MRI,<sup>26</sup> cardiac computed tomography (CT),<sup>27</sup> and echocardiography.<sup>28,29</sup> In clinical practice, LV mass by nuclear MPI is calculated simultaneously with ventricular volumes and ejection fraction, using the same operator choices for apical border, mitral valve plane, and epi- and endocardial borders.<sup>30</sup> Given the strong relation between LV mass and major adverse cardiac events, the 2017 guidelines of the *American Society of Nuclear Cardiology* promote the systematic incorporation of LV mass determinations into structured and standardized nuclear MPI reports.<sup>31</sup>

Cadmium-Zinc-Telluride SPECT cameras have provided an improvement in energy resolution and image quality compared to conventional Anger cameras.<sup>32</sup> Although this has led to an improvement in overall diagnostic accuracy,<sup>33</sup> there remain concerns regarding a decrease in specificity.<sup>34</sup> The authors tested two image reconstruction softwares in CZT SPECT MPI

to determine LV mass. They report that ECTb<sup>35</sup> somewhat overestimates LV mass at lower values and underestimates it at higher values, with more stable results obtained with Corridor-4DM.<sup>36</sup> This is likely due to the approach used in ECTb of ‘fitting’ gated cardiac results into a standardized 1 cm myocardial thickness model. Importantly however, the overall diagnostic power of CZT SPECT to define the presence and severity of LVH remained high compared to cardiac MRI, regardless of the software utilized. These results suggest the suitability of using these two software approaches to derive LV mass from gated CZT SPECT MPI studies.

Future research is needed to address remaining issues in the measurement of LV mass by SPECT MPI. Larger studies are warranted to address SPECT MPI-specific criteria to diagnose global LVH, independent of cardiac MRI. Furthermore, methods to assess focal LVH that occurs in a compensatory manner after myocardial infarction should also be explored. Given the plethora of data indicating that LV mass is a strong prognostic indicator, and given its routine computation from gated MPI studies, the present body of work will further support the growing emphasis to systematically include LV mass measures in all cardiac nuclear imaging reports.

## Disclosures

*Dr. Maddahi is a scientific advisor to Lantheus Medical Imaging and GE Healthcare.*

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