Approaches to measuring ejection fraction: Many tools, but how to decide which one?

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In today's clinical practice, non-invasive cardiac imaging is commonplace and utilized for assessment of left ventricular ejection fraction (LVEF). Evaluation of LVEF is important for diagnosis of heart disease and guiding decisions for pharmacologic and device-based therapies. Currently, several modalities are used for sequential evaluation of LVEF as an analysis of serial changes based on intercurrent treatments both for supportive (e.g., ACE inhibitors, beta blockers) as well as potential worsening (certain chemotherapeutic agents) functions. In addition to serial assessment for significant improvements and detection of clinical worsening, there is an inverse relationship between LVEF and cardiac mortality which is well established.[1-3] The literature is replete with evidence supporting an LVEF evaluation for assessment of functional recovery after revascularization in patients with chronic coronary artery disease (CAD).[3] Additional appropriate indications include evaluation of LVEF for comprehensive cardiac structural/perfusion assessment for which the LVEF is only part of the information obtained and is usually not the reason the particular test is chosen.[4-6] Current modalities used for this comprehensive evaluation include gated SPECT/PET, MRI, and CT.[7] As well, for LVEF assessment, radionuclide angiography (RNA) is also frequently employed with transthoracic echocardiography saddling both indications as a primary indication for testing.

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In this issue of the *Journal of Nuclear Cardiology*, Yang et al expands these conventional approaches for LVEF assessment through the evaluation of computed tomographic evaluation assessment for rest LVEF in isolation of angiographic evaluation of the extent and severity of CAD.[8] In this series, a total of 77 patients who were already scheduled to undergo LVEF assessment with RNA were also evaluated with an innovative CT LVEF protocol.[8] CT images were post-processed with the evaluation of a semi-automatic volumetric algorithm. The LVEF was calculated utilizing measurements of end-diastolic and end-systolic LV volumes. Importantly, the mean estimated effective radiation dose for the LVEF assessment was 4.7 mSv for CT vs 9.5 mSv for RNA. For CT, the assessment of LVEF required 4½ minutes of testing time which was less than the 9 minutes needed for RNA image acquisition. This difference became even more striking when compared to the total time for an RNA study of 85½ minutes.

In this report, Yang et al revealed a very strong correlation ($r = .86$) between the mean LVEF measured by RNA and CT. The observed LVEF measurements were statistically similar between CT and RNA with average values of 41.9% for CT and 39.4% for RNA ($P > 0.15$). Although the P value was close to the borderline threshold, the observed differences between CT and RNA were clinically minimal. Using a Bland–Altman analysis, the mean difference between techniques was only 2.4% and unlikely to result in marked differences in categorization of LVEF for CT when compared to RNA. With regards to specific categories of LVEF, the kappa statistics were also very high when comparing CT to RNA. For LVEF measurements of $\leq$30% and $\geq$50%, the kappa statistics were .69 and .75, respectively. These findings are clinically important for the focus of imaging to be patient-centered as it allows for improved efficiency in the diagnostic evaluation and is equally effective at differentiating both low- and high-risk patient subset. This report is not a comparative evaluation of which test is better but fosters an aim of effective and equivalent comparisons in order to enhance the variety of tools which may optimally guide imaging decision making.

The most common means for assessment of LVEF is with echocardiography. Of course, to all readers of this journal, echocardiography has distinct advantages especially that it does not expose the patient to ionizing radiation. Certainly, echocardiography is one commonly employed modality for LVEF assessment.

As noted as in the paper by Yang et al, a limitation with this CT protocol is that it did not allow simultaneous assessment of the coronary arteries. However, with future software and hardware advances, this will be feasible while keeping the decreased radiation exposure. Thus, the addition of both functional and anatomic assessment is one that is uniquely available with CT imaging as well as with magnetic resonance imaging. Certainly, there are some excluded, high-risk cohorts including selected subsets with chronic kidney disease, yet the current findings can be expected to provide decided advantages for a large cohort of patients with suspected CAD who may benefit from the measurement of LVEF. One additional analysis that may be useful is to examine what percentage of patients would require this added LVEF measurement as many studies have reported that preserved systolic function is uniformly documented in many lower-risk cohorts with a normal rest electrocardiogram and few cardiac risk factors.[9,10]

Data such as that put forth in this series are critical to the field of CT and benefits nuclear cardiology as it provides an alternative approach to the evaluation of left ventricular function without additional increases in the total radiation exposure. As was noted in the article by Yang et al, this technique will not be utilized routinely in its current iteration. Instead, it will be another tool that can be used in devising an individualized, patient-focused approach to LVEF assessment. Given the overlap in the utilization of both nuclear and CT, the results put forth in this report can only further the work of readers of this journal and provide expanded opportunities to optimally diagnose and guide clinical imaging of patients undergoing a diagnostic evaluation with CT.

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