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EDITORIAL COMMENT

# Assessment of left ventricular function: visual or quantitative?

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Assessment of cardiac function continues to be an important issue in patients with assumed left ventricular (LV) dysfunction [1–10]. In particular in patients with enlarged left ventricles, such as occurs in ischemic and idiopathic dilated cardiomyopathy, accurate assessment of LV function remains pivotal [11–14]. To assess myocardial function, different diagnostic methods are currently performed such as echocardiography, single photon emission computed tomography (SPECT), and cardiac magnetic resonance imaging (CMR) [15–23]. In the clinical arena, detection of myocardial function is predominantly based on echocardiographic studies. In addition, nuclear techniques, showing preserved tracer uptake and metabolism in viable myocardium, may also assess left ventricular function and wall motion. Volumetric analysis by gated SPECT imaging offers considerable additional value to SPECT myocardial perfusion imaging in characterizing functional abnormalities thereby potentially improving test specificity [24–37]. Subsequent to echocardiography and gated SPECT imaging, CMR has now long been recognized as an accurate and reliable means of evaluating LV function. Considerable progress has been made in the field of CMR, providing accurate evaluation of LV function parameters in coronary artery disease, heart failure, hypertrophic cardiomyopathy, and many other cardiac diseases [38–49]. CMR may be more accurate than echocardiography and gated SPECT in establishing LV volumetric parameters because of its more objective analysis and superb spatial resolution, respectively [50–58].

In the current issue of the *International Journal of Cardiovascular Imaging,* Holloway et al. [59] nicely determined the accuracy of visual analysis of LV function in comparison with the accepted quantitative reference standard CMR. Cine CMR imaging was performed at 1.5 T on 44 patients with a range of LV ejection fractions (EF) between 5 and 80%. Eighteen clinicians were asked to visually assess LVEF after sequentially being shown cine images of a four-chamber (horizontal long axis), two-chamber (vertical long axis) and a short axis stack. The authors found strong correlations between visual and quantitative assessment. However, LVEF was underestimated in all categories (by 8.4% for horizontal long axis, 8.4% for horizontal long axis + vertical long axis and 7.9% for horizontal long axis + vertical long axis + short axis stack). LVEF was particularly underestimated in patients with mild LV dysfunction (17.4%, $P < 0.01$), less for moderate (4.9%) and not for severe impairment (1%). It was concluded that assessing more than one view of the heart improved visual assessment of LVEF. However, the 18

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clinicians underestimated LVEF by 8.4% on average, with particular inaccuracy for those patients with mild LV dysfunction. Given the important clinical information provided by LV assessment, in particular in deformed left ventricles, the authors recommended quantitative analysis for accurate assessment of LV function.

Several studies have compared visual and quantitative assessment of LVEF, both in normal subjects and patients with impaired LV function [60–68]. Nearly all studies showed that LVEF is underestimated by visual estimation compared with the quantitative assessment. Holman et al. [65], using a dedicated analytical software package (MASS version 1.0) including a modified centerline method and a new 3D-analysis approach, showed in 25 patients after acute myocardial infarction that the use of three-dimensional quantitative analysis of cine CMR images accurately quantifies the extent of regional LV dysfunction in the infarcted heart. Van der Geest et al. [66] evaluated a computer algorithm for the automated detection of LV endocardial and epicardial boundaries in time series of short-axis CMR images based on an Active Appearance Motion Mode. In 20 short-axis CMR examinations, manual contours were defined in multiple temporal frames (from end-diastole to end-systole) in multiple slices from base to apex. Global LV function results derived from automatically detected contours were compared with results obtained from manually traced boundaries. Automated contour detection resulted in small, but statistically non-significant, underestimations of LV volumes and mass: and an excellent agreement was observed in the LVEF. The fully automated contour detection method provided assessment of quantitative global LV function that is comparable to manual analysis, but offered the advantage of being more consistent, more reproducible, and less operator-dependent. Sievers et al. [67] investigated 100 subjects (40 normal subjects, 40 patients with ischemic cardiomyopathy, and 20 patients with nonischemic cardiomyopathy) using a 1.5-T CMR imager. LVEF was significantly underestimated by the visual reader in all 3 groups. The difference was larger in normal subjects than in patients with cardiomyopathy. The interobserver variability was smaller for the quantitative assessment than for the visual estimation. Attili et al. [69] reported that recent quantitation-oriented advances in CMR hardware and software have resulted in significant improvements in image quality and a reduction in imaging time.

To conclude, the study by Holloway et al. [59] confirms that the visual CMR approach for LVEF assessment may be used for rapid assessment of LV function in clinical practice where accuracy is of less concern. For an accurate analysis of LV function, the quantitative standard short axis approach is required.



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