EDITORIAL COMMENT

Automated Cardiac Volumetric Analysis
One Step Closer to Incorporating 3D TTE Into Routine Daily Workflow*

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Three-dimensional (3D) transthoracic echocardiography has been available since the early 1970s to display cardiac images (1). The earliest systems used manual reconstruction of 2-dimensional (2D) images by computer algorithms to display the heart in 3D mode. Although the early systems were a leap in technology compared with standard 2D echo, the equipment was large, cumbersome to use, and impractical for daily use in most echo laboratories. As computer and chip technology advanced, allowing miniaturization of imaging and computing components, 3D echo technology became integrated into standard echo machines. Thus, 3D echo was finally able to move from the research arena to the bedside.

Numerous studies have shown the superior accuracy of 3D echo over 2D echo for the assessment of left ventricular (LV) volumes and left ventricular ejection fraction (LVEF). The most recent chamber quantification guidelines by the American Society of Echocardiography recommends 3D echo as a suitable modality for the volumetric assessment of the left ventricle (2). Despite the wealth of research demonstrating the accuracy and feasibility of this technique, however, utilization in daily use has been modest. There are multiple explanations for this phenomenon, including the higher cost of systems capable of 3D imaging, lack of reimbursement, additional training necessary to become facile with the technology, and the extra time needed to acquire, crop, and manually trace the 3D images to calculate LV volumes and LVEF.

In the study by Tsang et al. (3) in this issue of JACC, a novel automated algorithm to calculate LV volumes and LVEF using 3D echo datasets was assessed. The investigators also evaluated the algorithm to calculate left atrial (LA) volumes, an important measurement because current guidelines recommend LA volume assessment over linear dimensions (2). In this study, 3D images were acquired in 94 patients by using a transthoracic 3D echo system from a single vendor. Wide-angle full-volume acquisitions were made using 4 consecutive beats in a single breath-hold. Images were then manually traced in the standard fashion using commercial off-line software to calculate LV/LA volumes and LVEF. In addition, the 3D echo images were analyzed using the prototype-automated software. This automated software used a combination of shape orientation and motion analysis to first define the endocardial borders. Preliminary LV and LA models were then built using information from a 3D echo database containing approximately 1,000 3D transthoracic echo datasets of varying image quality in patients with a wide range of function and morphologies. Manual contour manipulation was allowed after the automated contours were generated.

Traditionally, cardiac magnetic resonance (CMR) has been used as the gold standard for cardiac volumes and LVEF. Numerous studies have shown that 3D echo-derived volumes are smaller than those obtained from CMR (4–6). To accurately compare the 3D dataset versus the gold standard, Tsang et al. (3) generated a second set of automated 3D echo models using values adjusted with information from a 3D echo CMR database. As a result, although the automated LA and LV volumes reflect the 3-dimensional echocardiography (3DE) data, the values produced were adjusted with knowledge of the relationship between the 3DE and CMR data. This unique method

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allows for a more accurate, “apples-to-apples” comparison of the 2 techniques.

The study by Tsang et al. (3) reported good correlation between the automated 3DE model and the manual 3DE measurements of LV/LA volumes and LVEF. With contour adjustment, the LVEF inter-technique bias was reduced but not eliminated. Contour adjustments had a minimal change in volumes. There was no significant difference noted in the LVEF measured using the gold standard CMR and the automated 3DE CMR model program without contour adjustment, but biases for the LV volumes were reduced after contour adjustments. Biases and limits of agreement were affected in both the 3D echo and 3D echo CMR algorithms in individuals with reduced ejection fraction and those with larger volumes acquired with volume rates <15 Hz. The time necessary to generate LV/LA volumes and LVEF was 144 ± 32 s for the manual tracing. Time was reduced to 26 ± 2 s for fully automated data sets and 76 ± 6 s for the automated datasets using contour correction.

This study (3) is unique in several ways. First, the study illustrated the accuracy and feasibility of an automated technique to calculate LV/LA volumes and LVEF using 3D echo datasets. The significant reduction in time has the potential to allow routine use of 3D echo technology in busy echo laboratories without compromising workflow. Second, 2 algorithms were studied, 1 using a robust 3D echo database that provides a “real-life” echo assessment and the second a 3D echo CMR database. The latter provides more reliable comparisons between 3D echo and CMR images and may potentially allow for a more unified definition of “normal” volumes and ejection fraction across modalities.

The study (3) was limited by use of a single vendor’s echo system, a relatively small sample size, enrolling only patients in sinus rhythm, and eliminating those with poor image quality. In addition, biases and agreement were diminished in individuals with a low LVEF and in those with large LV volumes acquired with volume rates <15 Hz. These limitations will only be overcome as 3D imaging technology improves. Finally, the algorithm showed that the best agreement in many instances is after contour correction, which adds time to the analysis.

The research by Tsang et al. (3) is an encouraging start to automating echo datasets. Continued improvements in 3D echo imaging technology and automated analytics software have the potential to overcome large barriers for use and integration of 3D echo in all echo laboratories.

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