The ability to imagine a 3-dimensional (3D) image of the heart was one of the earliest recognized benefits of 2-dimensional (2D) echocardiography at its inception 40 years ago. The ability to build such an image in real time has been a remarkable feat of image processing in the past decade. Intuitively, 3D imaging is the future of echocardiography, and the superiority of this method compared with 2D techniques is most apparent in the assessment of structural abnormalities (e.g., valvular heart disease and septal defects). In addition to these rendered images, quantitation of volume-based measurements, such as ejection fraction (EF), is better performed by 3D than with 2D echocardiographic techniques. After its development in 2D echocardiography, measurement of myocardial strain has recently been implemented in 3D echocardiography by multiple vendors. However, even though the 3D strain technique has been available for some years, many experts have considered that it was not yet ready for clinical implementation.

In this issue of *JACC*, Nagata et al. (1) present the utility of 3D strain to predict adverse events in asymptomatic patients with severe aortic stenosis and preserved EF. The correct timing of aortic valve replacement (AVR) is debated in this patient group, for whom watchful waiting is widely used. However, the risk of an expectant approach is that the patient could experience rapid deterioration of cardiac function and sudden death (2). Although estimating the risks of these events is difficult, statistical modeling has suggested that risk would have to be an order of magnitude higher than currently reported to justify intervention (3). Several attempts have been made to predict an adverse outcome, including assessment of biomarkers and echocardiographic studies. Nagata et al. (1) studied 114 patients with 2D and 3D strain and showed encouraging results for 3D strain. This modality was the best predictor of an adverse outcome and also had predictive value for mortality. Furthermore, 3D strain was marginally better compared with 2D global longitudinal strain to predict adverse outcomes also in patients with low-gradient, severe aortic stenosis, a condition that is particularly challenging to evaluate.

The current study is one of the first to report potential clinical benefits by using 3D strain imaging and may facilitate the use of 3D strain in clinical practice. The theoretical advantages of 3D strain are acquisition of full volume from 1 probe position and software that can follow speckles in 3 dimensions. The obvious disadvantages are image quality (including stitching defects), limited validation studies and definition of normal values, low temporal and spatial resolution, and even higher variability among vendors, similar to problems with 2D strain. In patients with severe aortic stenosis and preserved EF, the advantage of 3D strain in assessing the total left ventricular function may be of particular importance.

As shown in several studies, EF has excellent prognostic value in those with reduced cardiac function, but has limited prognostic value in those with relatively preserved cardiac function. The additional and prognostic information of 2D myocardial strain in patients with preserved EF was shown previously (4,5), and 3D strain might possess similar or even better prognostic value in patients with a normal EF. As always in medicine, intervention decisions should rarely rely on only 1 single parameter. With regard to
AVR timing in asymptomatic patients with severe aortic stenosis, 3D echocardiography might provide guidance as to when patients should be scheduled for early intervention and when watchful waiting may be a safe alternative.

This paper provides us with encouraging information about the value of 3D strain in this setting, but is it enough to change guidelines or practice? Probably not. A weakness of the study is that AVR was included as an adverse event, and therefore, the natural history in these aortic stenosis patients can only be speculated on. Second, the selection process to find suitable studies of adequate quality seemed onerous; 429 patients underwent 3D echocardiography, 133 met inclusion criteria, and 104 entered the study. Third, the correlation between 2D and 3D global longitudinal strain was only modest ($r = 0.56$), which seems troubling for 2 ways of measuring the same process. Fourth, and perhaps most important, we read of a 4% to 5% intraobserver variation and a 5% to 7% interobserver variation from the same images, but what we want to know relates to test-retest variation (i.e., repeat images). Previous papers have reported only moderate performance of this parameter, with discrepancies with 2D strain being most prominent when 3D strain was gathered at low temporal resolution (6). Finally, this study included a relatively small number of patients with short follow-up, and the superiority of 3D strain over 2D strain was only marginal. Before implementation of 3D strain in clinical practice, further studies should confirm the results of Nagata et al. (1).

The medical community is conservative and prefers well-documented methods. The time from the first research results to clinical acceptance can be long, as exemplified by the calculation of cardiac output by Doppler measurements, which we regard as a standard measure today (7). It took more than 10 years after the first report before that method was generally accepted in clinical practice. Thorny ways to clinical acceptance should therefore not discourage further studies and developments in 3D strain. Better image quality and processing power and more user-friendly software will obviously further improve these methods. At this stage, we should be patient and wait for these improvements before 3D strain can be widely accepted and included in our daily practice.

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