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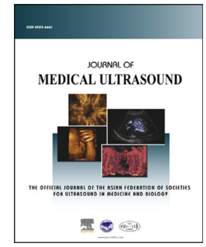

EDITORIAL

Measuring Myocardial Deformation: Should We Go Back from Two and Three Dimensions to Linear Measurement?

Evaluation of contractile function with echocardiography has traditionally been limited to volume-based assessment of ejection fraction (EF) and assessment of regional wall motion or visual estimation of regional thickening. Although left ventricular (LV) EF is one of the most powerful echocardiographic predictors of death or cardiovascular morbidity [1], it is limited as not only a measure of contractility by load dependency, but also for its prognostic value when in the low-normal range or higher [2], as well as for gross reductions in EF that are likely to represent fairly advanced functional impairment of the LV. These limitations have led to an interest in techniques that provide more objective and reproducible measures of contractile function.

Deformation imaging, for example, allows for more direct assessment of myocardial muscle shortening and lengthening throughout the cardiac cycle by assessing regional myocardial strain and strain rate. Strain is defined as the change in length of a segment of myocardium relative to its resting length and is expressed as a percentage; strain rate is the rate of this deformation. Previously, assessment of myocardial strain could be performed using sonomicrometry crystals, which can only be performed experimentally [3], or with magnetic resonance imaging-based myocardial tagging [4,5] that has the constraints of relatively low temporal resolution and the limited availability and expense of cardiac magnetic resonance imaging. Extension of these techniques to echocardiography has allowed for substantially greater utility in a broader range of patients.

Myocardial deformation imaging with echocardiography can be performed with the use of either tissue Doppler-based or two-dimensional (2D) speckle tracking-based methods. Because speckle tracking can be performed on 2D B-mode images, it is independent of angle of incidence and has been proven not only to be more robust than Doppler-based methods, but also to have good correlation with both sonomicrometry and myocardial tagging with magnetic resonance imaging [6,7]. Strain imaging has been used to gain greater understanding into the pathophysiology of cardiac ischemia and infarction [8–12], the primary diseases of the myocardium [13–19], and the effects of valvular heart disease on myocardial function [20–26]. Strain imaging has also been used to quantify abnormalities in the timing of mechanical activation for heart-failure patients undergoing cardiac resynchronization pacing therapy [27]. Further advances, such as three-dimensional (3D) speckle tracking strain imaging, have emerged to provide an even greater insight [28].

An interesting paper in the *Journal of Medical Ultrasound* presents an omni-directional M-mode echocardiography system that can measure radial myocardial motion velocity gradient (MVG) of LV [29]. The MVG is defined as the rate at which myocardial fibers shorten in length per unit time, and reflects the strain rate by measuring myocardial motion velocity differences between the inner and outer membranes of myocardial thickness ratio. The study showed that compared with the control group at the same plane, the MVGs of hypertrophic segments were decreased in both patients with hypertrophic cardiomyopathy (HCM) and in patients with hypertension with left ventricular hypertrophy (HLVH). The decrease of MVG in the patients with HLVH was less significant than that in the patients with HCM. These findings were consistent with previous studies using tissue Doppler-based [17,30] and 2D speckle tracking-based strain imaging [31,32]. Although the method seems feasible, there were some limitations that had to be considered. First, the analysis depends on a software that is not widely available, and this limits its clinical applications. Second, it was a linear analysis. Although 2D and 3D strain analysis can give us many parameters, such as longitudinal strain, circumferential strain, radial strain, area strain, and even torsion, M-mode-based analysis can only give us radial deformation. Linear

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analysis, compared with 2D and 3D, could potentially worsen the interobserver and intraobserver variability, as each time people may draw a different line for analysis. In each segment of the LV, the choice of which line would be representative of the whole segment is also a problem. Nevertheless, this article shows another method for LV analysis. However, a further large population study is warranted prior to widely applying this method.

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