EDITORIAL COMMENT

Three-dimensional speckle tracking echocardiography: The future is now

Ecocardiografia tridimensional de *speckle tracking*: o futuro é agora

Rogério Teixeira [a,b]

[a] *Cardiology Department, Hospital Geral, Centro Hospitalar e Universitário de Coimbra, Portugal*
[b] *Faculty of Medicine, University of Coimbra, Coimbra, Portugal*

Cardiac ultrasound is an imaging modality that enables dynamic imaging of the heart and great vessels. The past decade has seen the development of two-dimensional speckle tracking echocardiography (2D-STE), a semi-automated technique based on frame-by-frame tracking of tiny echo-dense speckles within the myocardium that reveals the extent of lengthening and shortening relative to the baseline (Lagrangian strain).[1] It enables assessment of motion and deformation parameters such as velocity, displacement, strain, and strain rate in the left ventricular longitudinal, radial, or circumferential axis.[1] This non-Doppler methodology is therefore able to provide information on segmental and global myocardial deformation. Myocardial 2D-STE has been validated by comparison with sonomicrometry[2] and tagged magnetic resonance imaging (MRI).[3]

With respect to left ventricular (LV) mechanics, global longitudinal strain (GLS) is the most-studied 2D-STE parameter and is part of routine assessment in many echocardiographic laboratories. This is in contrast to analysis of radial and circumferential LV mechanics, which are probably not sufficiently reproducible.[4] By convention, GLS is presented as negative values representing shortening in the longitudinal LV axis. In a meta-analysis of 24 studies which included 2597 healthy subjects, GLS varied from -15.9% to -22.1%.[5] The American Society of Echocardiography suggests a value above -20% with a standard deviation of ±2% as likely to be normal.[6]

To date, most strain data have come from non-randomized, retrospective studies. GLS has been proposed for the detection of myocardial ischemia,[7] to differentiate among various hypertrophy etiologies,[8] to monitor therapy, and as a tool to detect heart disease in the preclinical stage.[9] A recent 2017 review identifies four settings in which GLS can provide additional (if not potentially incremental) clinical utility: undifferentiated left ventricular hypertrophy; assessment of cardiotoxicity; aortic stenosis; and ischemic heart disease.[4]

The use of 2D-ST has been expanded and validated for the other cardiac chambers (right ventricle and left and right atrium)[1] as well as the aortic wall.[10]

Ultrasound systems are now capable of acquiring real-time volumetric LV data. Three-dimensional (3D) techniques can measure all strain components in all LV segments and LV torsion from a single acquisition.[11] 3D speckle tracking echocardiography (3D-STE) thus offers an opportunity to overcome a significant limitation of 2D-STE: out-of-plane speckle motion.[4]

Nevertheless, tracking in three dimensions is challenging, as both the spatial and the temporal resolution of the 3D data set are inferior to 2D imaging, and there is the possibility of speckle decorrelation between subsequent volumes.[12,13] Even so, 3D-STE has been validated in simulated models, in vitro and in vivo, against sonomicrometry and MRI markers.[11] LV 3D-STE has been shown to be a reliable

technique for the assessment of LV global systolic function, highly correlated with left ventricular ejection fraction and Doppler-derived cardiac output.[14] Subsequent studies in different clinical scenarios such as ischemia and hypertensive and valvular heart disease have provided further evidence of the utility of LV 3D-STE.[11]

In this issue of the *Journal*, Guedes et al.,[15] using both classic and advanced echocardiographic parameters, present a study of a group of patients with myotonic dystrophy type 1 (DM1) with no established cardiovascular disease plus a control group of healthy subjects. Regarding advanced imaging, the authors focused on 3D LV myocardial mechanics assessed with an Artida scanner (Toshiba® Medical Systems). The following parameters of LV cardiac mechanics were calculated: LV longitudinal, radial and circumferential strain; LV area tracking; and twist. The authors concluded that DM1 patients had lower values of 3D LV longitudinal strain than the control group. Moreover, assessment of 2D myocardial mechanics did not identify differences between the groups, in contrast to 3D assessment. Based on previous data from clinical studies,[16] 2D-STE[17] and cardiac MRI of myocardial fibrosis[18] in DM1 patients, the authors theorized that this 3D LV longitudinal strain reduction could represent subclinical myocardial damage.

Although these results are of interest, some limitations are to be noted. Speckle-tracking analyses can be complex and time-consuming, and can generally only be obtained from high-quality images. It is therefore important to provide data regarding feasibility. Secondly, inter- and intra-observer variability in assessment of cardiac mechanics (and echocardiography in general) is a concern. The intra-class correlation coefficient can be used, but, for simplicity, other measures of variability may be more appropriate, such as the absolute difference divided by the mean of repeated observations, expressed as a percentage. Finally, the overlap of values between cases and controls makes it unlikely that 3D-STE will in fact add real value in clinical practice.

Conflicts of interest

The author has no conflicts of interest to declare.

Acknowledgment

References

1. Mor-Avi V, Lang RM, Badano LP, et al. Current and evolving echocardiographic techniques for the quantitative evaluation of cardiac mechanics: ASE/EAE consensus statement on methodology and indications endorsed by the Japanese Society of Echocardiography. J Am Soc Echocardiogr. 2011;24: 277–313.
2. Korinek J, Wang J, Sengupta PP, et al. Two-dimensional strain – a Doppler-independent ultrasound method for quantitation of regional deformation: validation in vitro and in vivo. J Am Soc Echocardiogr. 2005;18:1247–53.
3. Cho GY, Chan J, Leano R, et al. Comparison of two-dimensional speckle and tissue velocity based strain and validation with harmonic phase magnetic resonance imaging. Am J Cardiol. 2006;97:1661–6.
4. Collier P, Phelan D, Klein A. A test in context: myocardial strain measured by speckle-tracking echocardiography. J Am Coll Cardiol. 2017;69:1043–56.
5. Yingchoncharoen T, Agarwal S, Popovic ZB, et al. Normal ranges of left ventricular strain: a meta-analysis. J Am Soc Echocardiogr. 2013;26:185–91.
6. Lang RM, Badano LP, Mor-Avi V, et al. Recommendations for cardiac chamber quantification by echocardiography in adults: an update from the American Society of Echocardiography and the European Association of Cardiovascular Imaging. J Am Soc Echocardiogr. 2015;28:1–39.e14.
7. Hanekom L, Jenkins C, Jeffries L, et al. Incremental value of strain rate analysis as an adjunct to wall-motion scoring for assessment of myocardial viability by dobutamine echocardiography: a follow-up study after revascularization. Circulation. 2005;112:3892–900.
8. Weidemann F, Niemann M, Ertl G, et al. The different faces of echocardiographic left ventricular hypertrophy: clues to the etiology. J Am Soc Echocardiogr. 2010;23: 793–801.
9. Ganame J, Claus P, Eyskens B, et al. Acute cardiac functional and morphological changes after anthracycline infusions in children. Am J Cardiol. 2007;99:974–7.
10. Teixeira R, Vieira MJ, Goncalves A, et al. Ultrasonographic vascular mechanics to assess arterial stiffness: a review. Eur Heart J Cardiovasc Imaging. 2015;17:233–46.
11. Jasaityte R, Heyde B, D'Hooge J. Current state of three-dimensional myocardial strain estimation using echocardiography. J Am Soc Echocardiogr. 2012;26:15–28.
12. Papademetris X, Sinusas AJ, Dione DP, et al. Estimation of 3D left ventricular deformation from echocardiography. Med Image Anal. 2001;5:17–28.
13. Elen A, Choi HF, Loeckx D, et al. Three-dimensional cardiac strain estimation using spatio-temporal elastic registration of ultrasound images: a feasibility study. IEEE Trans Med Imaging. 2008;27:1580–91.
14. Kleijn SA, Aly MF, Terwee CB, et al. Three-dimensional speckle tracking echocardiography for automatic assessment of global and regional left ventricular function based on area strain. J Am Soc Echocardiogr. 2011;24:314–21.
15. Guedes H, Moreno N, Santos RP, et al. Importance of three-dimensional speckle tracking in the assessment of left atrial and ventricular dysfunction in patients with myotonic dystrophy type 1. Rev Port Cardiol. 2018;37: 333–8.
16. Sa MI, Cabral S, Costa PD, et al. Cardiac involvement in type 1 myotonic dystrophy. Rev Port Cardiol. 2007;26: 829–40.
17. Garcia R, Rehman M, Goujeau C, et al. Left ventricular longitudinal strain impairment predicts cardiovascular events in asymptomatic type 1 myotonic dystrophy. Int J Cardiol. 2017;243:424–30.
18. Petri H, Ahtarovski KA, Vejlstrup N, et al. Myocardial fibrosis in patients with myotonic dystrophy type 1: a cardiovascular magnetic resonance study. J Cardiovasc Magn Reson. 2014; 16:59.