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A novel insight into pathophysiology of hypertrophic cardiomyopathy using simultaneous three-dimensional volume-strain loops.

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Topic(s): 3D Echocardiography

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Background: Strain assessment offers a robust evaluation of myocardial mechanics and systolic function, however reporting only peak strain values in hypertrophic cardiomyopathy (HCM) may impose limitations in the conception of its complex remodeling. Therefore, combined plotting of deformation parameters against other indices [e.g. arterial pressure, left ventricular (LV) volume] might offer additional insights into the pathophysiology of the disease.

Purpose: Aim of this study was i) to apply strain-volume loops in HCM based on simultaneous frame-by-frame strain and volume changes’ recordings acquired by means of three-dimensional (3D) speckle tracking imaging and ii) to take advantage of the previous methodology to gain further insights into HCM pathophysiology.

Methods: We included 40 HCM patients (54.1±14.3 years, 82.5% male, maximum wall thickness 19.3±4.8mm) who have consecutively undergone 3D-speckle tracking echocardiography and cardiovascular magnetic resonance (CMR) with late gadolinium enhancement (LGE). Values of 3D strain were plotted vs. volume for each frame to build a strain–volume loop. Peak of radial, longitudinal, and circumferential systolic strain (Rsp, Lsp, and Csp, respectively), systolic slopes of the loops (RsSl, LsSl, CsSl), and strain to end-diastolic volume (EDV) ratio (Rs/V, Ls/V, Cs/V) were computed for the analysis (panel A). Additionally, burden of fibrosis (percentage of LV mass) was defined by LGE extent (>5 standard deviations compared to nulled myocardium) in CMR slices.

Results: All HCM patients had preserved EF (60.5±5.7%), while 16 (40%) had LV outflow tract obstruction (LVOTO>30 mm Hg at rest). Mean LV mass index was 78.9±14.5 g (evaluated by 3D echocardiography). LGE was observed in 23 patients (57.5%) occupying 5.2±4.5% of LV mass. Concerning strain-volume loops the following values were recorded for radial (Rsp 30.8±9.8%, RsSl 0.4±0.13 and Rs/V 0.25±0.09), longitudinal (Lsp -9.4±3.7%, LsSl 0.12±0.06 and Ls/V 0.08±0.04) and circumferential deformation (Csp -14.2±3.5%, CsSl 0.18±0.05 and Cs/V 0.11±0.03). Among typical HCM characteristics tested (LV mass, LVOTO and LGE), only peak LV mass presented significant correlations with LsSl (r=-0.41, p<0.01). Interestingly, HCM patients with smaller LVMI and without LGE presented steeper and narrower (difference between systolic and diastolic strain for the same volume) longitudinal strain-volume loops compared to patients with larger LVMIs and fibrosis (panel B).

Conclusions: Strain-volume loop is an innovative application of 3D deformation imaging in HCM. According to this new non-invasive method, increase of LVMI in HCM is accompanied by less longitudinal contribution to stroke volume, whereas absence of fibrosis and severe hypertrophy is accompanied by better systolic-diastolic coupling.
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