

MEETING REPORT

Abstract 1: Quantifying the effect of image quality on three-dimensional speckle tracking echocardiography

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Background

Three-dimensional speckle-tracking echocardiography (3D-STE) is believed to be influenced by the image quality, although quantitative evidence on this is limited. A previous evaluation indicated that sub-optimal image quality introduces a systematic bias in 3D-STE derived left ventricular (LV) deformation indices (1, 2). Therefore, we aimed to quantify the extent of bias in proportion to impairment in image quality.

Methods

This was a prospective experimental study. Eighteen healthy participants (age 31 ± 6 years, 83.3% men) with good echocardiographic windows underwent 3D echocardiography (3DE). To impair the quality of the 3DE images of the LV in a reproducible and graded manner, a sheet of ultrasound-attenuating material, neoprene rubber, of three different thicknesses (2, 3 and 4 mm) was used to mimic mild, moderate and severe impairment in image quality, respectively. Four gated LV 3DE full-volume datasets (including the optimal quality reference) were acquired per participant. All acquisitions were free of stitching artefacts and similar frame rates were maintained throughout. LV volumetric, and global and

segmental LV deformation indices were measured. Mixed linear modelling was used to estimate the extent of bias.

Results

There was a systematic bias in all global and segmental LV strains, and LV rotational indices. The extent of this systematic underestimation was in proportion to the impairment in image quality of the 3D images (i.e. the poorer the image quality, the larger the bias) (Table 1). Volumetric measures, including LV ejection fraction and LV systolic dyssynchrony index, were also increasingly underestimated relative to the grade of impairment in image quality (Table 1).

Conclusions

The systematic bias introduced by sub-optimal image quality on 3D-STE derived LV deformation indices is in proportion to and directly linked to the grade of impairment in image quality. Image quality should be assessed and accounted for in 3D-STE studies.

Table 1 The extent of bias in proportion to impairment in image quality on LV deformation indices measured by three-dimensional speckle-tracking echocardiography.

	Extent of bias relative to the reference				P (trend)	Mean (95% CI)			
	Mean Δ (95% CI)			Reference		Mean (95% CI)			
	Mild	Moderate	Severe			Mild	Moderate	Severe	
Global LV deformation indices									
GCS, %	1.6 (0.89, 2.4)	1.8 (0.99, 2.5)	2.6 (1.9, 3.4)	<0.0001	-26.2 (-27.0, -23.3)	-24.6 (-25.4, -23.7)	-24.4 (-25.3, -23.6)	-23.6 (-24.4, -22.7)	
GLS, %	0.47 (-0.34, 1.3)	0.89 (0.08, 1.7)	2.0 (1.2, 2.8)	<0.0001	-20.8 (-21.6, -19.9)	-20.3 (-21.1, -19.5)	-19.8 (-20.7, -19.1)	-18.7 (-19.5, -17.9)	
Basal rotation, °	0.14 (-1.5, 1.8)	1.9 (0.16, 3.5)	2.6 (0.90, 4.3)	0.001	-7.1 (-8.4, -5.7)	-6.9 (-8.3, -5.5)	--5.2 (-6.6, -3.8)	-4.5 (-5.8, -3.1)	
Apical rotation, °	-1.1 (-2.8, 0.49)	-2.6 (-4.3, -1.0)	-3.0 (-4.7, -1.4)	<0.0001	6.7 (5.2, 8.1)	5.5 (4.1, 7.0)	4.0 (2.6, 5.5)	3.6 (2.1, 5.1)	
Twist, °	-1.5 (-4.6, 1.6)	-4.7 (-7.8, -1.6)	-5.9 (-9.1, -2.8)	<0.0001	13.5 (10.9, 16.2)	12.1 (9.4, 14.7)	8.8 (6.2, 11.5)	7.6 (4.9, 10.2)	
Torsion, °/cm	-0.12 (-0.45, 0.21)	-0.47 (-0.81, -0.14)	-0.63 (-0.96, -0.29)	<0.0001	1.5 (1.2, 1.7)	1.3 (1.1, 1.6)	0.99 (0.70, 1.3)	0.84 (0.55, 1.1)	
Averaged* segmental LV deformation indices									
CS, %	1.4 (0.54, 2.3)	1.6 (0.69, 2.5)	2.9 (2.0, 3.8)	<0.0001	-26.0 (-26.9, -25.1)	-24.6 (-25.5, -23.7)	-24.4 (-25.3, -23.5)	-23.1 (-24.0, -22.1)	
LS, %	0.60 (-0.26, 1.5)	1.1 (0.23, 1.97)	2.0 (1.1, 2.9)	<0.0001	-20.5 (-21.3, -19.7)	-19.9 (-20.7, -19.0)	-19.4 (-20.2, -18.6)	-18.5 (-19.3, -17.7)	
PTS, %	1.0 (0.04, 2.0)	1.4 (0.40, 2.4)	1.8 (0.81, 2.8)	<0.0001	-31.8 (-32.6, -30.9)	-30.7 (-31.6, -29.8)	-30.4 (-31.2, -29.5)	-29.9 (-30.8, -29.0)	
RS, %	-1.7 (-2.6, -0.7)	-2.2 (-3.1, -1.3)	-4.0 (-5.0, -3.1)	<0.0001	39.1 (38.1, 40.1)	37.4 (36.4, 38.4)	36.9 (35.9, 37.9)	35.1 (34.1, 36.1)	
LV systolic dyssynchrony index									
SDI _{volume-based} , %	-0.02 (-0.6, 0.6)	-0.79 (-1.4, -0.17)	-1.1 (-1.7, -0.5)	<0.0001	4.4 (3.9, 4.9)	4.4 (3.9, 4.9)	3.6 (3.1, 4.2)	3.3 (2.8, 3.8)	
Global LV volumetric indices									
EDV, mL	-7.8 (-14.5, -1.0)	-11.8 (-18.5, -5.0)	-19.5 (-26.3, -12.8)	<0.0001	139.6 (129.6, 149.5)	131.8 (121.8, 141.7)	127.8 (117.8, 137.7)	120.0 (110.0, 130.0)	
ESV, mL	-1.9 (-5.1, 1.3)	-2.5 (-5.7, 0.69)	-5.1 (-8.3, -1.8)	0.002	62.5 (57.3, 67.7)	60.5 (55.3, 65.8)	59.9 (54.7, 65.2)	57.4 (52.2, 62.6)	
EF, %	-1.2 (-1.9, -0.46)	-2.2 (-2.9, -1.5)	-3.2 (-3.9, -2.5)	<0.0001	55.4 (54.4, 56.4)	54.2 (53.2, 55.2)	53.1 (52.1, 54.2)	52.2 (51.2, 53.2)	
SV, mL	-5.8 (-9.6, -2.1)	-9.3 (-13.0, -5.5)	-14.5 (-18.3, -10.7)	<0.0001	77.1 (72.0, 82.1)	71.2 (66.2, 76.3)	67.8 (62.8, 72.9)	62.6 (57.5, 67.6)	

Data are means (95% confidence intervals).

*Averaged based on 16-segments model. The frame rate = 21.1 ± 3.0 frame/sec (reference data-sets), = 21.0 ± 3.2 frame/sec (mildly impaired data-sets), 21.0 ± 3.2 frame/sec (moderately impaired data-sets), and 20.8 ± 3.0 frame/sec (severely impaired data-sets).

CS, circumferential strain; EDV, end-diastolic volume; EF, ejection fraction; ESV, end-systolic volume; GCS, global circumferential strain; GLS, global longitudinal strain; LS, longitudinal strain; LV, left ventricular; PTS, principle tangential strain; RS, radial strain; SDI, systolic dyssynchrony index; SV, stroke volume.

Declaration of interest

The authors declare that there is no conflict of interest that could be perceived as prejudicing the impartiality of this article.

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