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The impact of simplified endocardial contouring on left ventricular volumetric assessment

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Study objective

To assess the impact of simplified endocardial contouring, performed manually and using semi-automated software, on left ventricular (LV) volumetric assessment.

Background

Cardiovascular magnetic resonance (CMR) is the gold standard for LV volumetric assessment. Detailed tracing of the endocardial border, including papillary muscles and trabeculations, can be time consuming. In many centres it is clinical practice to simplify this and trace the general outline of the endocardial border instead. Such analysis means that all non-wall adherent trabeculations are included in the LV cavity rather than within the myocardium. We aimed to assess the impact of manual and semi-automated simplified endocardial contouring on the accuracy and reproducibility of LV volumetric assessment.

Methods

20 consecutive patients undergoing clinically indicated CMR imaging were included. SSFP cine images were obtained using a 1.5 T scanner (Siemens Avanto, Germany) and a 32-channel coil system. Images were independently analysed by 2 observers using 3 software packages; 1. CMRtools (UK) which includes a thresholding tool allowing detailed endocardial border tracing, used as the reference standard in this study; 2. Siemens Argus ("Argus")-simplified manual endocardial contouring; 3. Siemens Argus 4DVF ("4DVF")-semi-automated simplified endocardial contouring. 25% of scans were reanalysed to assess intra-observer reproducibility. Time taken for each analysis was recorded.

Results

Mean EF measured by Argus (58 + 15%) and 4DVF (53 + 10%) were both significantly lower than EF measured by CMRtools (50 + 12%, p < 0.001 for Argus, p = 0.04 for 4DVF). End-diastolic- and end-systolic volumes measured with Argus (EDV 181 + 52 mls, ESV 92 + 36 mls, p < 0.001 for both) and 4DVF (175 + 48 mls, p = 0.008, 84 + 31 mls p = 0.015) were significantly lower than measured with CMRtools (159 + 50 mls, 67 + 32 mls). Inter- and intra-observer reproducibility were extremely high for CMRtools. Reproducibility for Argus was slightly lower, but still high (EF data presented in Table 1, 2, 3). Time taken for analysis using Argus was significantly shorter than for CMRtools (5 + 1 mins v 8 + 1 mins, p < 0.001), however CMRtools analysis time included measurement of LV mass. The reproducibility of 4DVF was low and analysis took significantly longer than with other methods.

Table 1: Mean (+SD) volumetric data and analysis time for each method

	CMR tools	Argus	4DVF
EF (%)	58 + 15	50 + 12	53 + 10
EDV (mls)	159 + 50	181 + 52	175 + 48
ESV (mls)	67 + 32	92 + 36	84 + 31
Analysis time (mins)	8 + 1	5 + 1	13 + 9

Table 2: Comparison of EF measured by each technique

	Mean difference +SD (%)	*p*-value	Correlation coefficient (r)	Bland-Altman 95% limits of agreement (%)	Bland-Altman Range (%)
CMR tools - Argus	8.5 + 5	< 0.001	0.95	-1.5 to 18.5	20
CMR tools - 4DVF	6 + 12	0.04	0.57	-18 to 30	48
Argus - 4DVF	-3 + 11	0.27	0.49	-24 to 19	43

Table 3: EF inter- and intra-observer reproducibility

	Mean difference +SD (%)	*p*-value	Correlation coefficient (r)	Bland-Altman 95% limits of agreement (%)	Bland-Altman range (%)
Interobserver variability	-0.3 + 1	0.35	0.99	-2 to 2	4
CMR Tools	0.4 + 2	0.27	0.97	-4 to 4	8
Argus 4DVF	3.2 + 9	0.22	0.58	-15 to 21	36
Intraobserver variability	0.1 + 1	0.78	0.99	-2 to 2	4
CMR Tools	0.8 + 2	0.20	0.98	-3 to 4	7
Argus 4DVF	-3.0 + 4.5	0.08	0.93	-11 to 6	17

Conclusion

Simplified manual endocardial contouring is time saving and reproducible, however it significantly overestimates LV volumes and underestimates EF, which could have significant implications for clinical decision making. In our hands, the semi-automated simplified endocardial contouring software did not provide any advantages.