Automatic measurements of left ventricular volumes and ejection fraction by artificial intelligence reduces time-consumption and inter-observer variability

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Background: Left ventricular (LV) volumes and ejection fraction (EF) are the most used and studied parameters in echocardiography, but they are hampered with the tedious nature and limited reproducibility of manual measurements. We developed an artificial intelligence (AI) decision-support software that automatically calculates LV volumes and EF by identifying the view, timing, and endocardial border from echo images.

Purpose: Our aim was to investigate the impact of using the AI decision-support software for automatic measurements of LV volumes and EF compared to standard care in real-time and large databases.

Methods: We compared biplane three-cycle averaged AI measurements of LV volumes and EF to manual references in multiple samples: 1) Real-time AI-support during scanning of 50 consecutive patients compared to standard care (test-retest) by two of three experts, 2) comparison of test-retest variability in inter- and intra-observer scenarios in 40 subjects with test-retest datasets by separate observers and measurements by AI and four experienced observers, 3) an internal database of 1881 subjects with manual references by Simpson's method, and 4) an external population of 849 subjects with manual references by semi-automatic tracking-based software. The influence on time consumption was tested in Sample 1. The influence on test-retest variability was tested in Sample 1 and 2, while the other samples were used to test the agreement with echocardiographic references.

Results: Used in real-time the AI measurements reduced total time-consumption by median (95% CI) 5.3 (4.8–6.5) minutes per patient ($p < 0.001$). The test-retest variability for AI-measurements were superior to inter-observer scenarios ($p < 0.05$) and non-inferior to intra-observer scenarios ($p < 0.025$, one-sided, delta=46% increased variance). The agreement with echocardiographic references was good (Figure). The biases (AI minus reference) ranged −11.6 to 6.5 mL for end-diastolic LV volume and −5.5 to 0.3 %-points for EF.

Conclusion: Fully automatic AI measurements of LV volumes and EF reduced time-consumption with 5 minutes, reduced test-retest variability compared to inter-observer analyses, and showed acceptable agreement with manual measurements in a wide range of scenarios. Thus, implementation of real-time fully automatic measurements of LV volumes and EF during scanning may improve the everyday workflow and quality in the everyday clinic.