The automatic identification of left ventricular chambers and quantification of ejection fraction using a novel artificial intelligence-based system - a validation against cardiac magnetic resonance.

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Background: Cardiac magnetic resonance imaging (CMR) is regarded as the reference method in assessing left ventricular (LV) ejection fraction (EF). However, 2-dimensional echocardiography (2D-Echo) is the most frequently used technique due to availability and practicability. The interpretation of 2D-Echo examinations depends on the user's expertise and may vary between different operators. A novel vendor independent software based on artificial intelligence (AI) performs both, automated evaluation of 2DEcho exams and calculations of LV EF in one workflow.
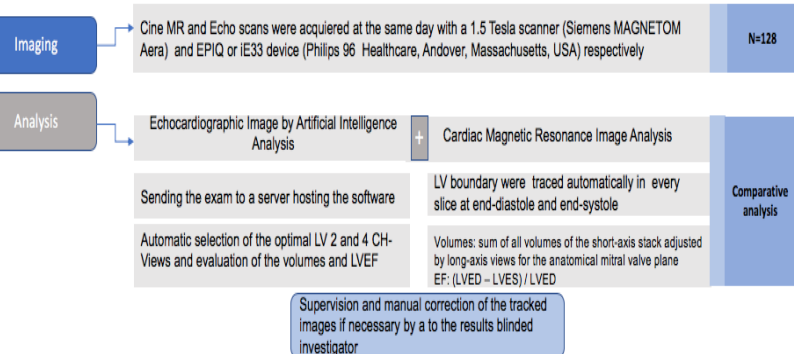

Figure 1: Illustration of the methodology

Methods: We consecutively enrolled 128 patients who underwent clinically indicated CMR examinations and performed a standard 2D-Echo at the same day. The server-based AI solution recognized the optimal LV 4CV and 2CV from 2D-Echo according to quality and depth criteria and performed calculation of biplane EF by endocardial borderline detection without user's involvement. LV EF from CMR was supervised by independent specialists blinded to the results of the AI. Pearson's correlation (R) and Bland-Altman analysis with limits of agreement (LOA) were performed in order to assess agreement/bias between the two methods. Significance was defined as a 2-tailed P value < 0.05.
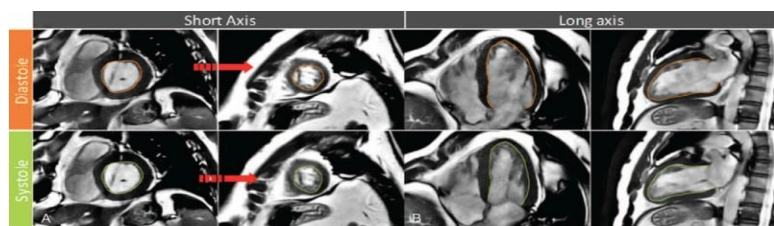

Figure 2: Quantification of the LV-Volumes and LVEF using CMR

Figure 3: Quantification of the LV-Volumes and LVEF using the AI software (LVivo)

Results: CMR was performed and LV EF was measured in all 128 patients. The median age was 60 years [20- 86], 65% were males and CMR was performed due to coronary artery diseases (33%), suspected/florid myocarditis (20%) or further diagnosis of non-ischemic heart failure (47%). Eleven cases (9%) did not pass AI's criteria due to impaired acoustic window or poor 2D-Echo images. The AI system detected either 4CV or 2CV (ratio 1.2) in 13 patients (10%), and both 4CV and 2CV in 104 patients (81% overall feasibility) with a correct classification of 100%. For these 104 patients an excellent correlation was found for AI's biplane LV EF and LV EF from CMR with r=0.91 (p 76.7±5.5% vs. 70.0±5.9%, p=0.312).

Patient characteristics (n = 104)	
Age (yrs)	60 (48.75 ; 76.0)
Sex male % (n)	63 (65)
Height (cm)	172 (168 ; 180)
Weight (kg)	82.5 (73.0 ; 90.0)
Body Surface Area (m2)	1.98 (1.84 ; 2.11)
Body Mass Index (kg/qm)	27.24 (24.04;29.24)

Table 1: Baseline characteristics; Median (1Q;3Q)

Echo/CMR characteristics (n = 104)	
Biplan LVEF using AI	39.2 (2.3;48.5)
Biplan LVEDV using AI	133.5(104.6;177.3)
Biplan LVESV using ai	79.0 (57.5;140.0)
LVEF in CMR	39.1 (25.0;53.4)
LVEDV in CMR	206.0 (157.5;288.5)
LVESV in CMR	115.5 (79.0;210.5)

Table 2: measured LVEF and Volumes using the AI software and in CMR ; Median (1Q;3Q)
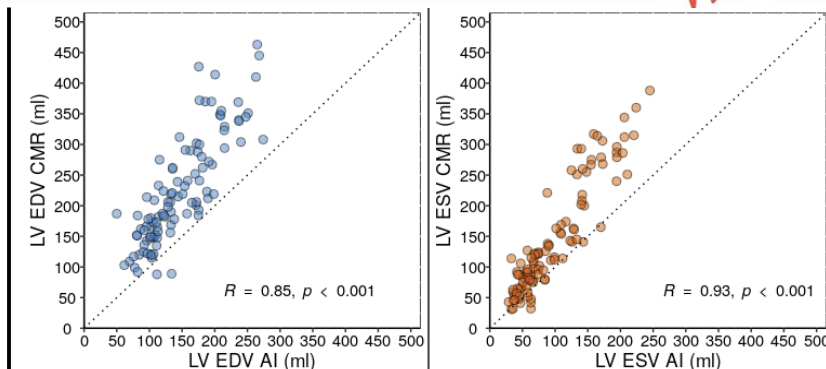

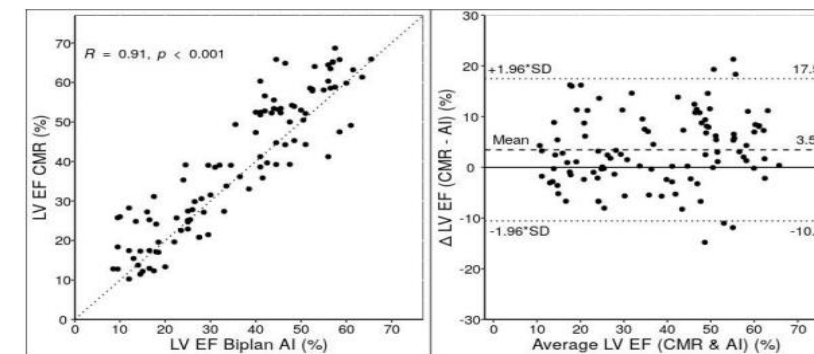Figure 4: Correlation plot between the LV-Volumes in CMR and using the AI software

Figure 5 : Correlation plot (left) and Bland-Altman plot (right) between LVEF in CMR and the AI software

Conclusion: The results provided by the AI-based software showed good capabilities and perfect classification rate to identify 4CV and 2CV. In addition, the LV EF results were excellent compared to CMR, especially since our study did not include "echocardiographically" pre-selected patients. However, differences between AI and CMR measurements are not negligible and warrant further investigation.