Automatic left-ventricular view detection and ejection fraction assessment by artificial intelligence models in echocardiography

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Background

- **Left ventricular (LV) border segmentation** is crucial for assessing LV size and function.
- Current evaluation shows **high inter-observer variability**.
- **Artificial intelligence (AI)** may deliver faster and more reproducible assessments, making **LV size and function accessible** even to non-experts.

Purpose

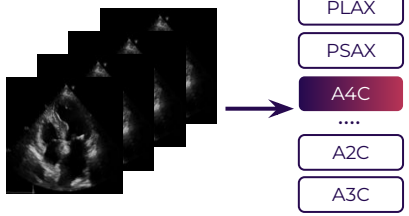
To develop AI models for the following tasks:

1. **View** identification
2. **LV Wall** segmentation
3. Computation of **LV Ejection Fraction** (EF)

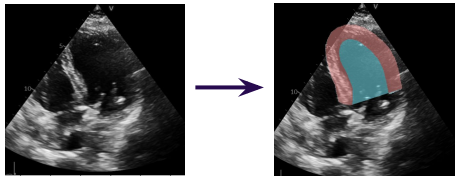
To validate on external cohort of LV segmentation and EF (CAMUS[1])

Methodology

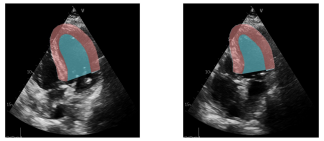
View identification



LV wall segmentation



EF computation



$$EF = \frac{(EDV - ESV)}{EDV} * 100$$

488 transthoracic echocardiographic (TTE) studies from Vall d'Hebron University Hospital were used to develop the models.

A total of **6,831 videos** for **view identification** and **619 for LV wall segmentation** were annotated.

AI models identified apical **4–chamber views** and **segmented LV wall**.

For the computation of **EF**, **end-diastolic (EDV) and end-systolic (ESV) LV volumes** were used.

Results

View Identification (% accuracy)

2–Chamber	3–Chamber	4–Chamber	Not Apical
88%	89%	94%	97%

Segmentation (DICE score)

		LV cavity	LV wall	LV overall
View specific	2–Chamber	0.86 [0.79 – 0.90]	0.79 [0.74 – 0.83]	0.91 [0.86 – 0.93]
	3–Chamber	0.88 [0.84 – 0.91]	0.81 [0.77 – 0.83]	0.91 [0.90 – 0.93]
	4–Chamber	0.90 [0.86 – 0.93]	0.82 [0.79 – 0.85]	0.92 [0.88 – 0.94]
Cardiac Rhythm	Sinus Rhythm	0.89 [0.85 – 0.91]	0.81 [0.77 – 0.83]	0.91 [0.88 – 0.93]
	Atrial Fibrillation	0.69 [0.64 – 0.82]	0.75 [0.57 – 0.80]	0.89 [0.74 – 0.94]
Image Quality	Acceptable	0.85 [0.76 – 0.89]	0.79 [0.75 – 0.82]	0.91 [0.87 – 0.93]
	Good	0.88 [0.76 – 0.89]	0.81 [0.77 – 0.83]	0.91 [0.87 – 0.91]
	Excellent	0.90 [0.89 – 0.91]	0.84 [0.81 – 0.85]	0.93 [0.90 – 0.95]
Sex	Male	0.88 [0.85 – 0.91]	0.81 [0.77 – 0.84]	0.92 [0.89 – 0.94]
	Female	0.88 [0.85 – 0.92]	0.81 [0.76 – 0.83]	0.91 [0.87 – 0.93]
External Validation	2 and 4-Chamber	0.80 [0.73 – 0.84]	-	0.91 [0.87 – 0.94]

EF Estimation

Cohort	Internal	R = 0.39	**p < 0.001**	Error = 12.0%
	External	R = 0.31	**p < 0.001**	Error = 2.2%

Conclusions

★ An **artificial intelligence model** can **identify** echocardiographic **views, segment** the **LV** and use the segmentation to **quantify EF**.

★ **Special care** should be considered in patients with **atrial fibrillation** and in **low quality** images.

[1] S. Leclerc, *et al.* IEEE Transactions on Medical Imaging. 2019

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