Role of myocardial deformation analyzed by 3D echocardiography in Fabry disease

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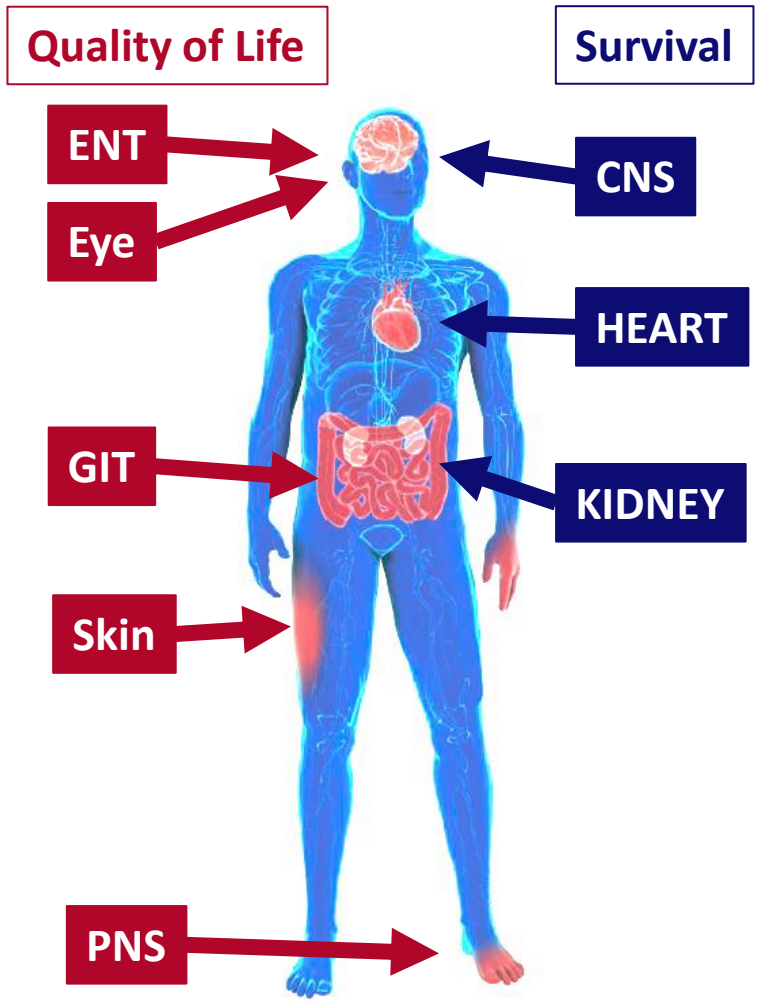
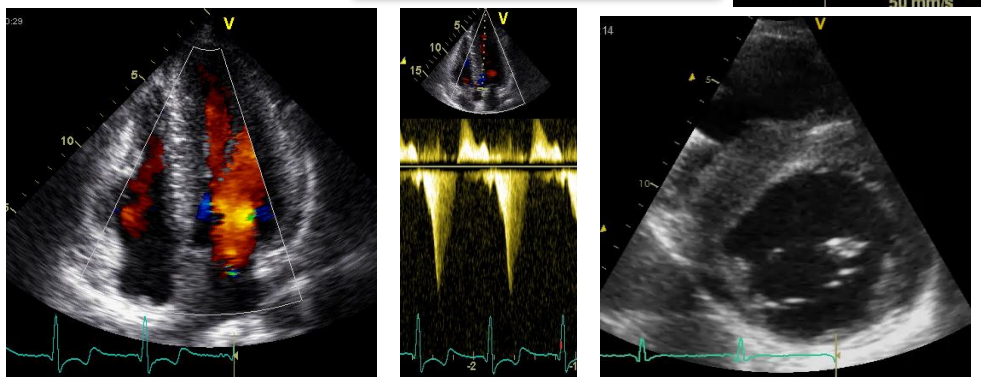
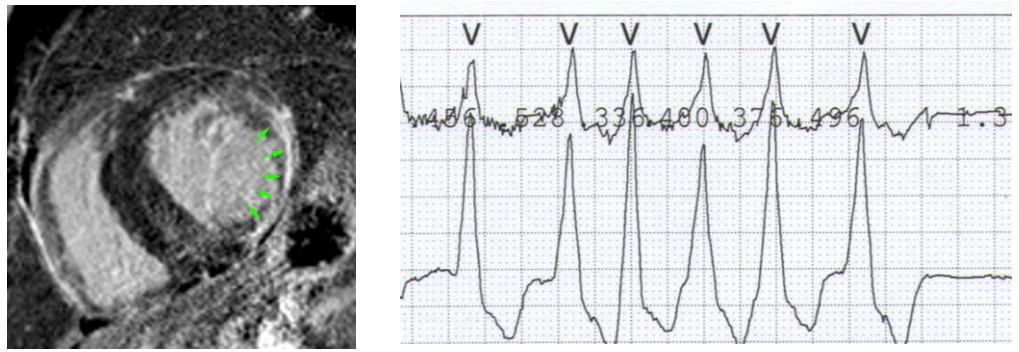
Anderson-Fabry disease and heart



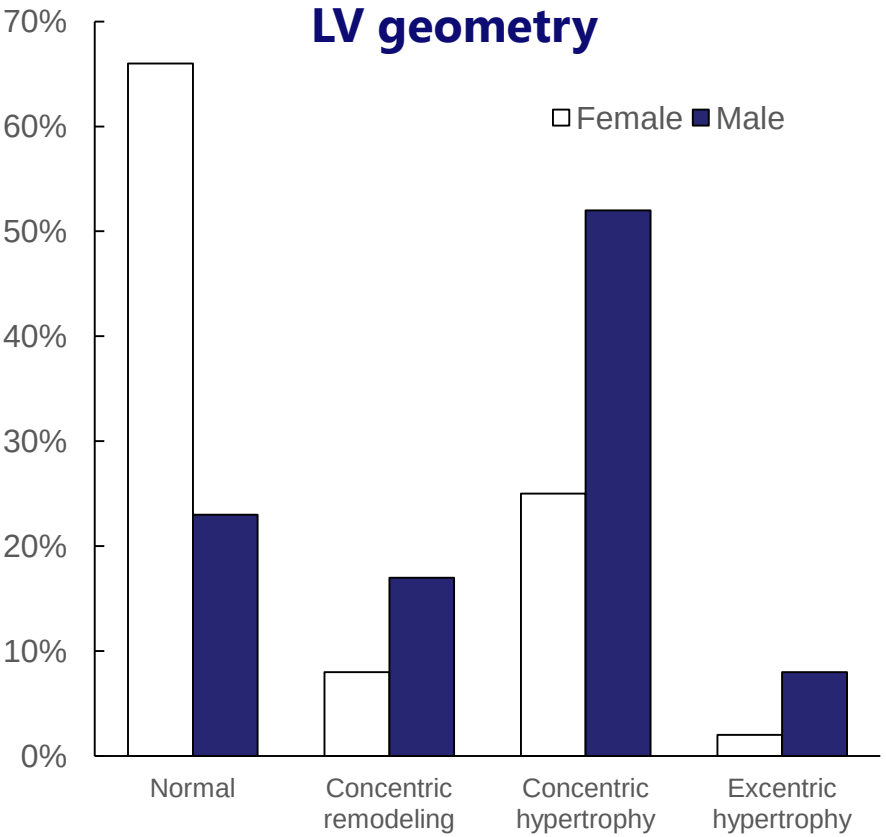




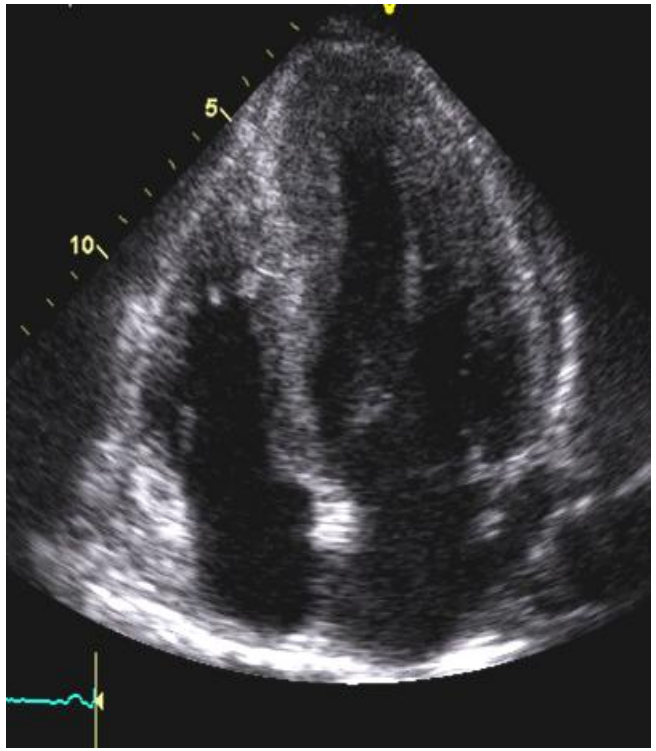
Germain et al. Orphanet J Rare Dis. 2010 Nov 22;5:30.
Linhart et al. Eur Heart J. 2007 May;28(10):1228-3
Images: General Teaching Hospital

Left ventricular morphology and function in Anderson-Fabry disease

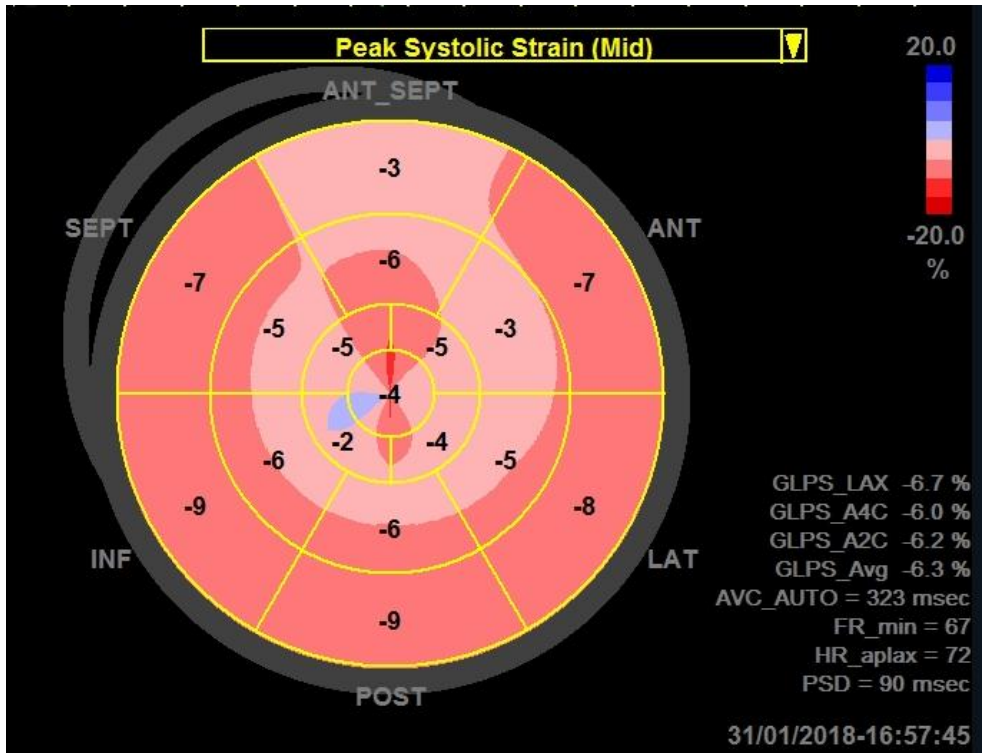
LV geometry



Morphology



Systolic function

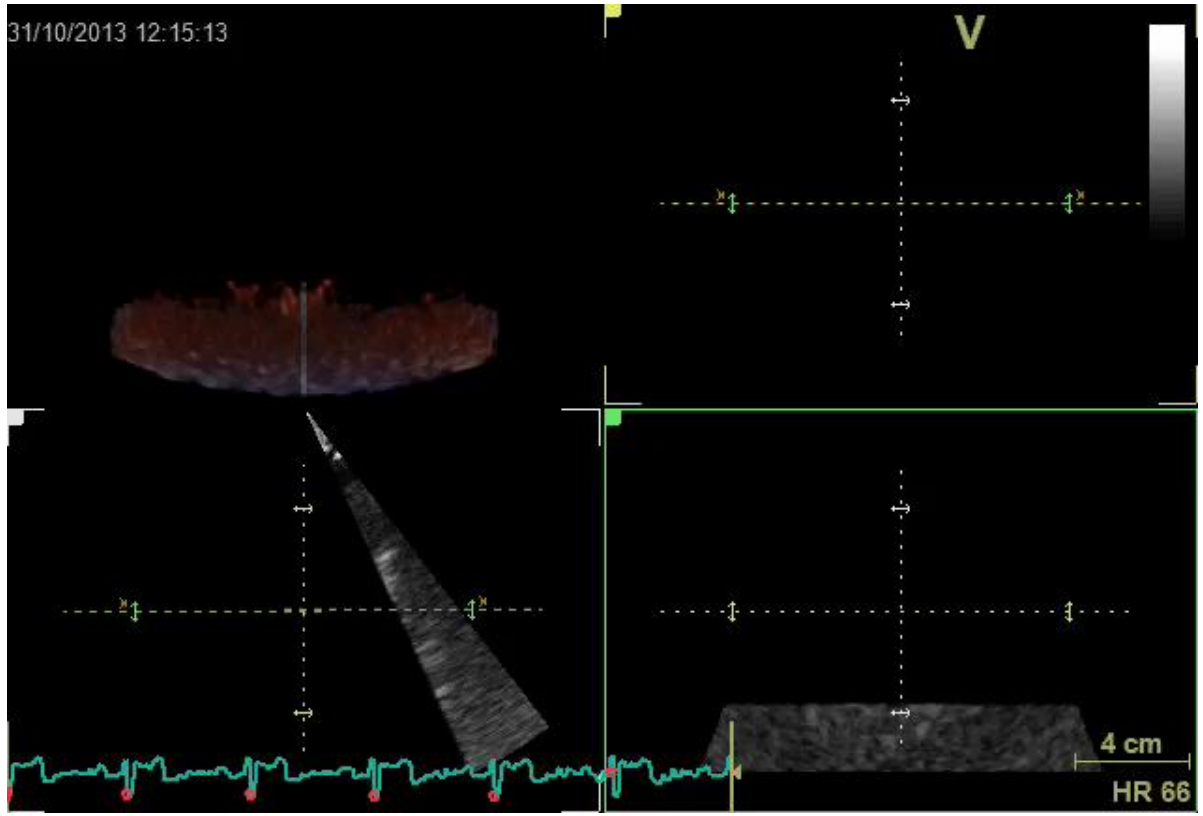


Concentric LV remodelling or hypertrophy
Preserved ejection fraction, decreased longitudinal function

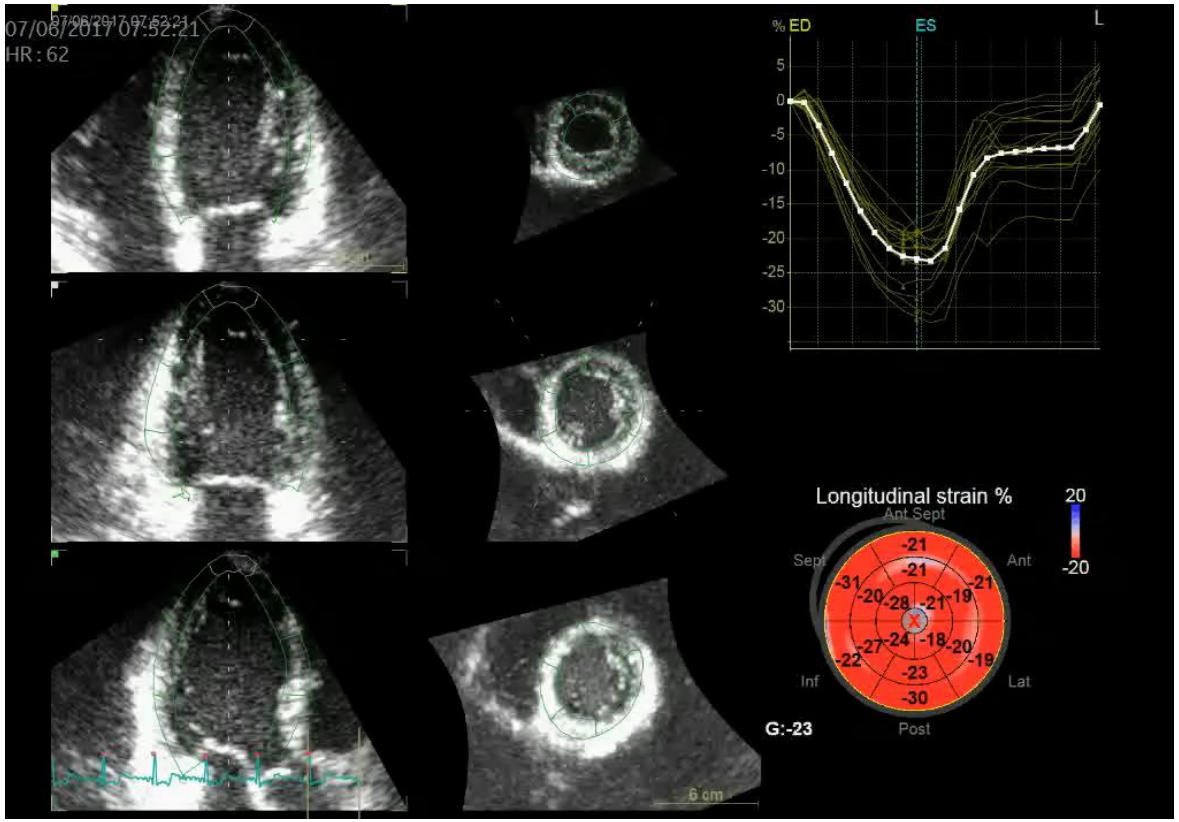
Linhart et al. Eur Heart J. 2007 May;28(10):1228-3; Rob et al. ESC Heart Fail. 2022 Aug 29. doi: 10.1002/ehf2.14091 Images: General Teaching Hospital

Three dimensional echocardiography

Gated acquisition



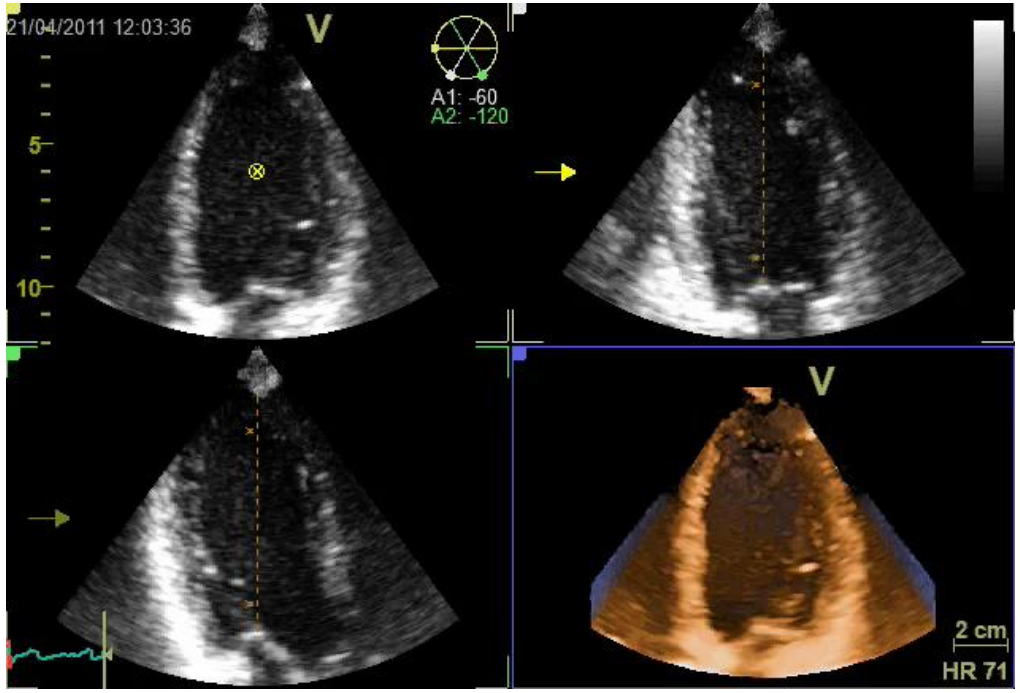
Semiautomatic analysis



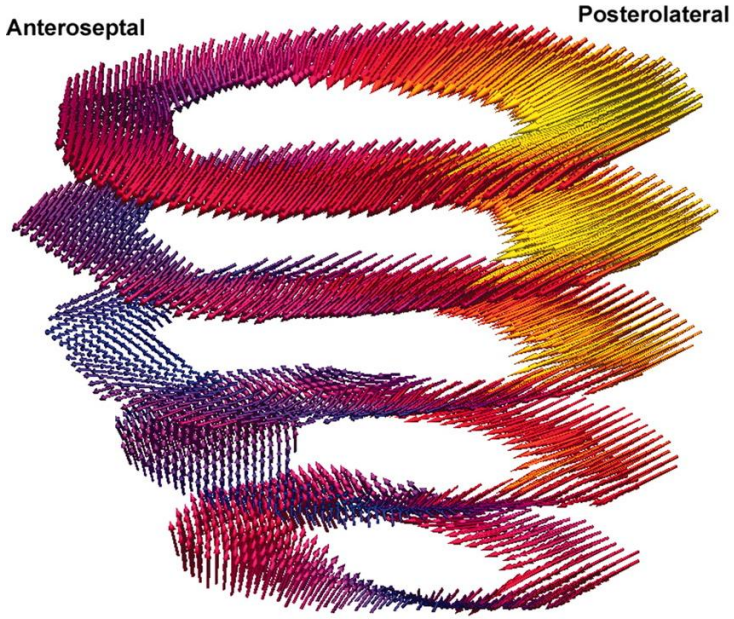
Lang et al. Eur Heart J Cardiovasc Imaging. 2012 Jan;13(1):1-46. Images: General Teaching Hospital

Myocardial deformation in three dimensions

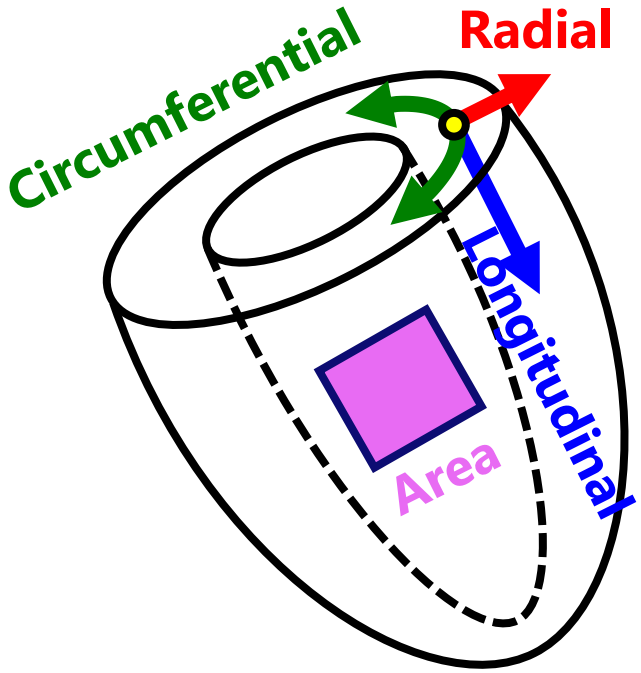
3D Dataset



Deformation in „reality“



Model



Am J Physiol Heart Circ Physiol. 2005 Sep;289(3):H1099-105

Population and baseline characteristics

3D echocardiography feasible in 75/99 pts
correlation with NT peptides
comparison to CMR LGE

long-term follow-up:
mortality
HF worsening
CV hospitalization

median f-up 3.1 years

Demography	n = 75
Age	47 ± 14
Female gender	42 (56%)
BMI	25 [23,28]
Mainz Severity Score Index	16 [7, 27]
Enzyme replacement therapy	48 (64%)
Arterial hypertension	31 (41%)
Hyperlipidemia	28 (37%)
Diabetes	3 (4%)

Functional capacity	
NYHA	
0/I	47 (63 %)
II	22 (29 %)
III	5 (8 %)
IV	1 (1 %)
Six minute walk test distance	500 [400, 550]

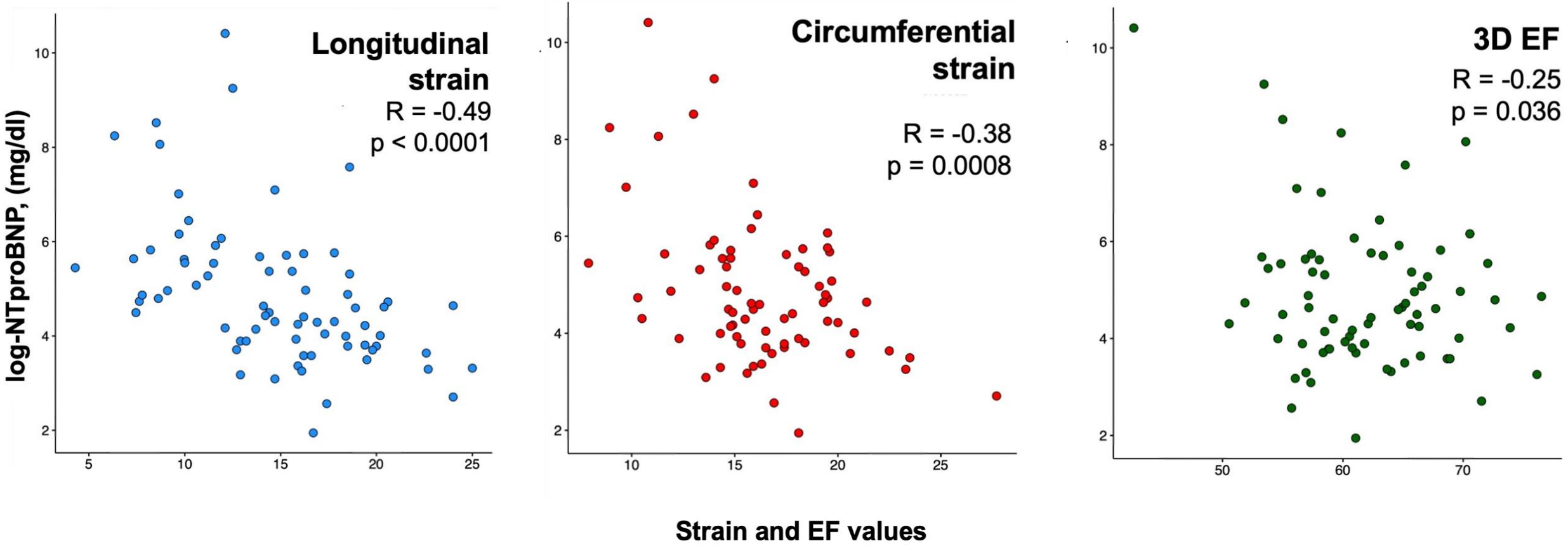
Laboratory values	
Abnormal NP	34 (45%)
Creatinine	72 [62,91]
eGFR	97 [78, 109]
eGFR < 60	11 (15 %)

CMR – cardiovascular magnetic resonance, LGE – late gadolinium enhancement, NP – Natriuretic peptides

Echocardiographic findings by gender

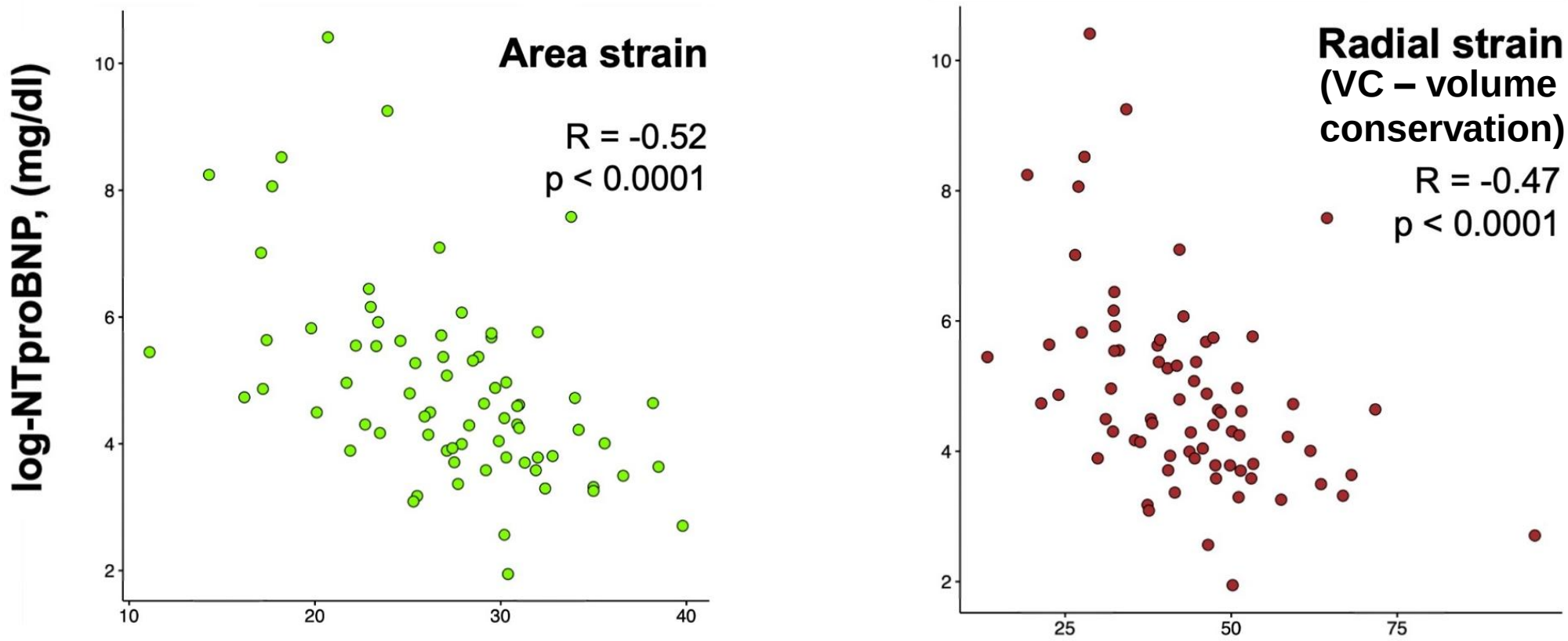
Echo parametry	Male	Female	p
Left ventricular mass indexed (g/m^2)	140 [105 , 155]	72 [62 , 94]	< 0.001
Relative wall thickness	0.52 [0.42 , 0.6]	0.37 [0.31 , 0.46]	< 0.001
Ejection fraction (%)	66 ± 7	64 ± 6	0.27
2D global longitudinal strain (%)	15 ± 4	20 ± 4	< 0.001
E/e‘	9.8 [8.2 , 14.0]	7.8 [6.4 , 9.3]	< 0.001
Left atrial volume indexed (ml/m^2)	35 [28 , 44]	29 [24 , 34]	0.011
3D Ejection fraction (%)	62 ± 7	62 ± 6	0.78
3D Global circumferential strain (%)	16 ± 4	17 ± 4	0.25
3D Global longitudinal strain (%)	12 ± 4	17 ± 4	< 0.001

Correlation with NTproBNP: 3D longitudinal and circumferential strain, EF



Correlation with NTproBNP stronger for *longitudinal than circumferential* strain
Correlation of NTproBNP with EF only borderline significant

Correlation with NTproBNP: 3D specific strains



Significant association for 3D-specific area strain and for calculated radial strain

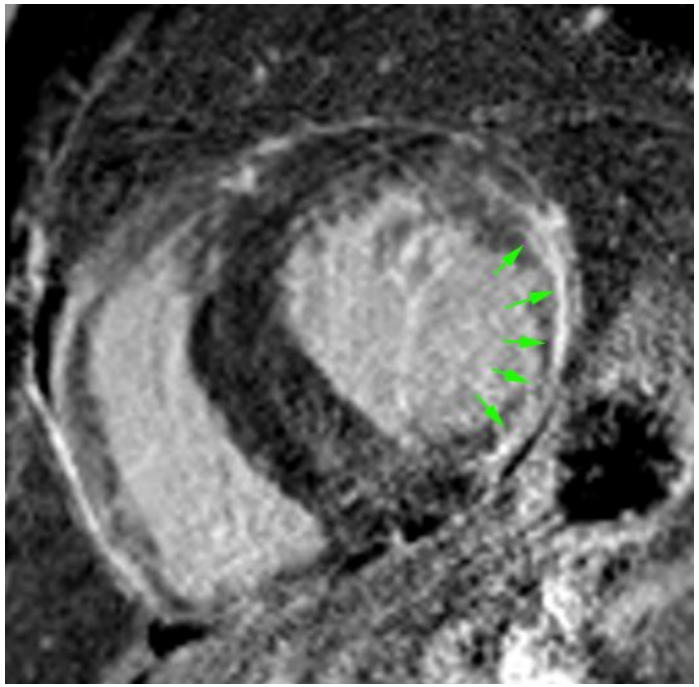
Predictors of NTproBNP: 3D strain and EF

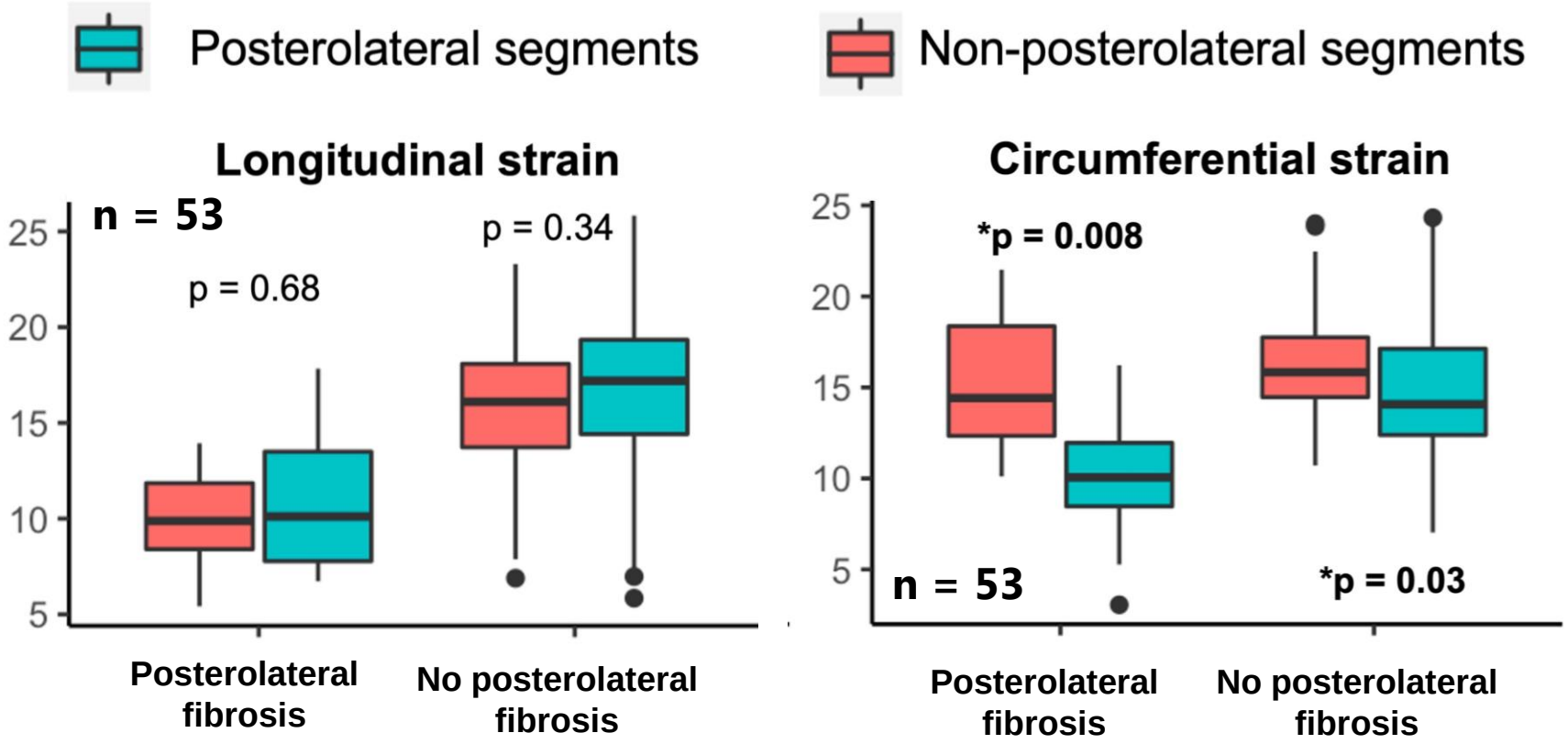
Variable (3D LV)	Unadjusted			Adjusted*		
	β	95%CI	p value	β	95%CI	p value
Longitudinal strain	-0.16	[-0.23, -0.10]	<0.0001	**-0.11**	**[-0.18, -0.04]**	**0.0020**
Circumferential strain	-0.16	[-0.25, -0.07]	0.0008	-0.08	[-0.15, -0.01]	0.0350
Area strain	-0.14	[-0.19, -0.08]	<0.0001	-0.08	[-0.13, -0.03]	0.0022
Radial strain	-0.05	[-0.08, -0.03]	<0.0001	-0.03	[-0.05, -0.01]	0.0050
Ejection fraction	-0.06	[-0.11, 0.00]	0.0362	-0.02	[-0.06, 0.03]	0.4329

Global 3D longitudinal strain was the strongest adjusted predictor of natriuretic peptide levels

* - age, gender and renal function; HF – heart failure, CV - cardiovascular

Posterolateral scar and 3D regional strain





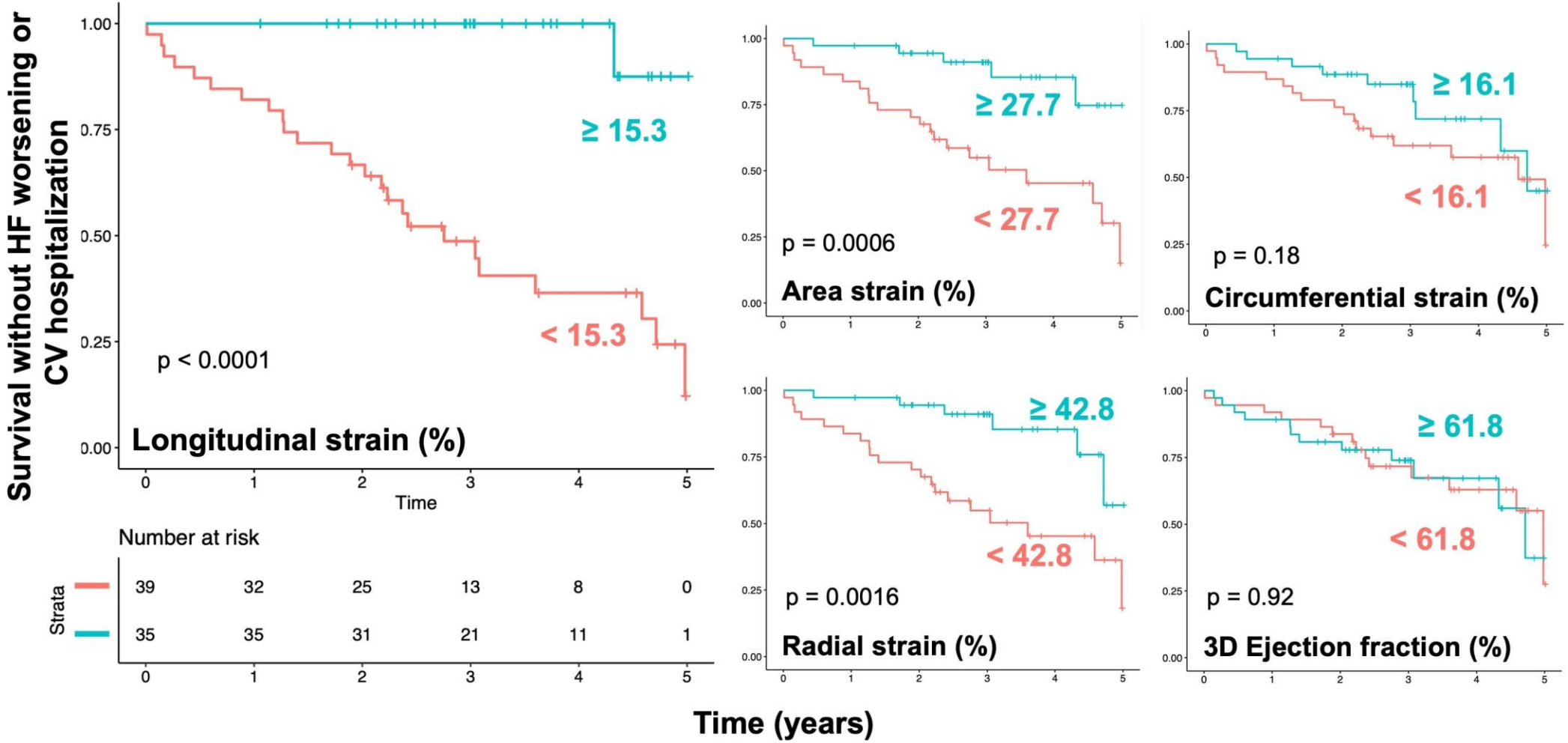
In patients with posterolateral LGE-scar:

***circumferential* strain significantly decreased in scarred vs. other segments**

***longitudinal* strain decreased overall in all segments**

LGE – late gadolinium enhancement; Images: General Teaching Hospital

Predictors of long term combinded outcome: mortality, HF worsening, CV hospitalization



Global 3D longitudinal strain was the strongest predictor of outcome

HF – heart failure, CV - cardiovascular

Adjusted long term outcome (Cox PH)

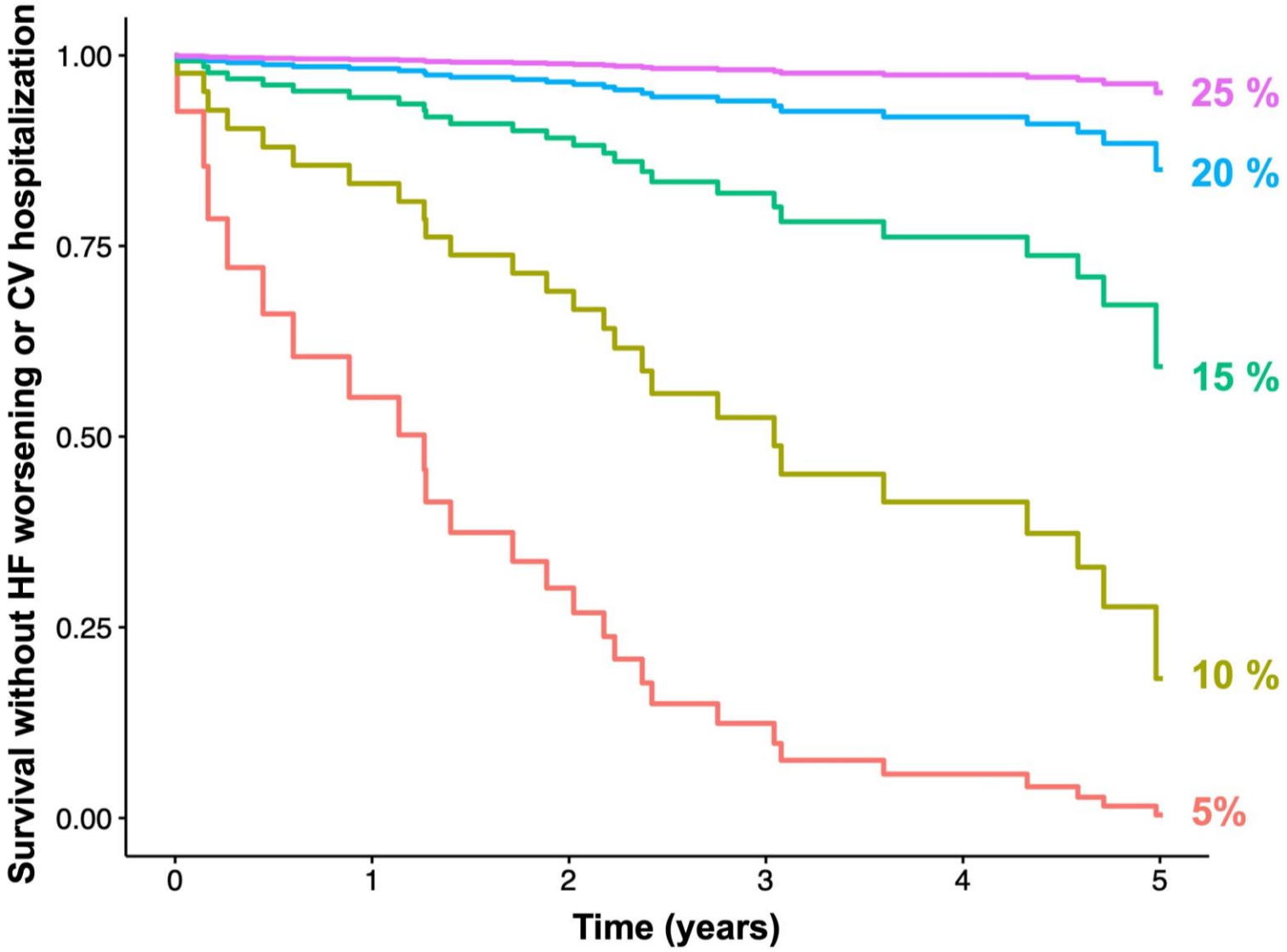
Variable (3D LV)	Unadjusted			Adjusted*		
	HR	95%CI	p value	HR	95%CI	p value
Longitudinal strain	0.79	[0.72, 0.87]	<0.0001	**0.84**	**[0.75,0.95]**	**0.004**
Circumferential strain	0.87	[0.77, 0.98]	0.0183	0.94	[0.85,1.10]	0.284
Area strain	0.87	[0.82, 0.93]	< 0.0001	0.93	[0.86,1.00]	0.04
Radial strain	0.93	[0.90, 0.97]	0.0001	0.96	[0.93,1.00]	0.038
Ejection fraction	1.02	[0.96, 1.10]	0.4242	-	-	-

***longitudinal* strain was the strongest adjusted predictor of long term outcome**

***circumferential* strain was not significantly associated with long term outcome**

* - age, gender and renal function; Cox PH – Cox proportional hazards model

Estimated long-term outcome based on 3D global longitudinal strain



Limitations

- need for **dedicated 3D probe** and specialized software analysis
- **good apical window needed** for adequate visualization of all segments
- **need for regurlar rhythm** - gating acquisition can generate stitching artifacts
- difficult endocardial border tracking in hypertrophic phenotypes

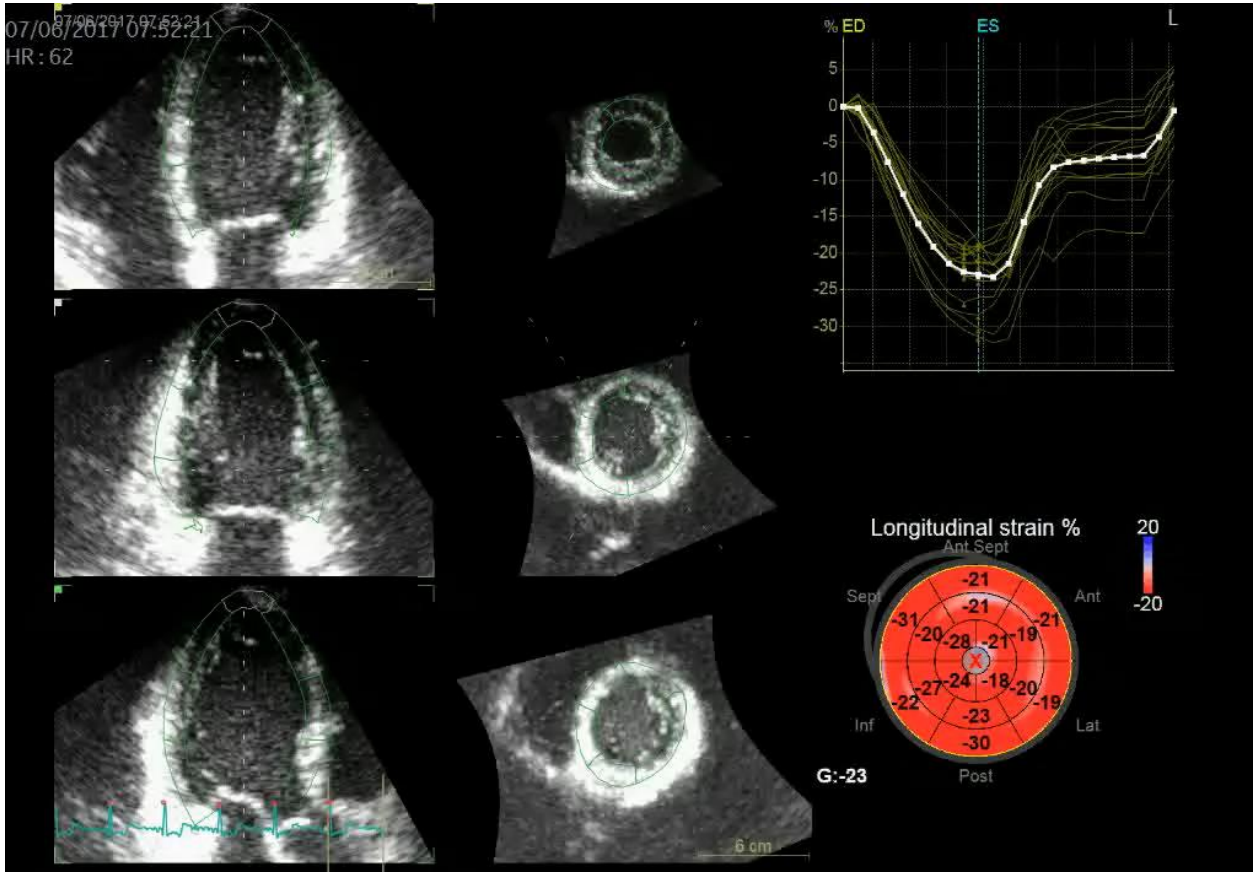
Conclusions

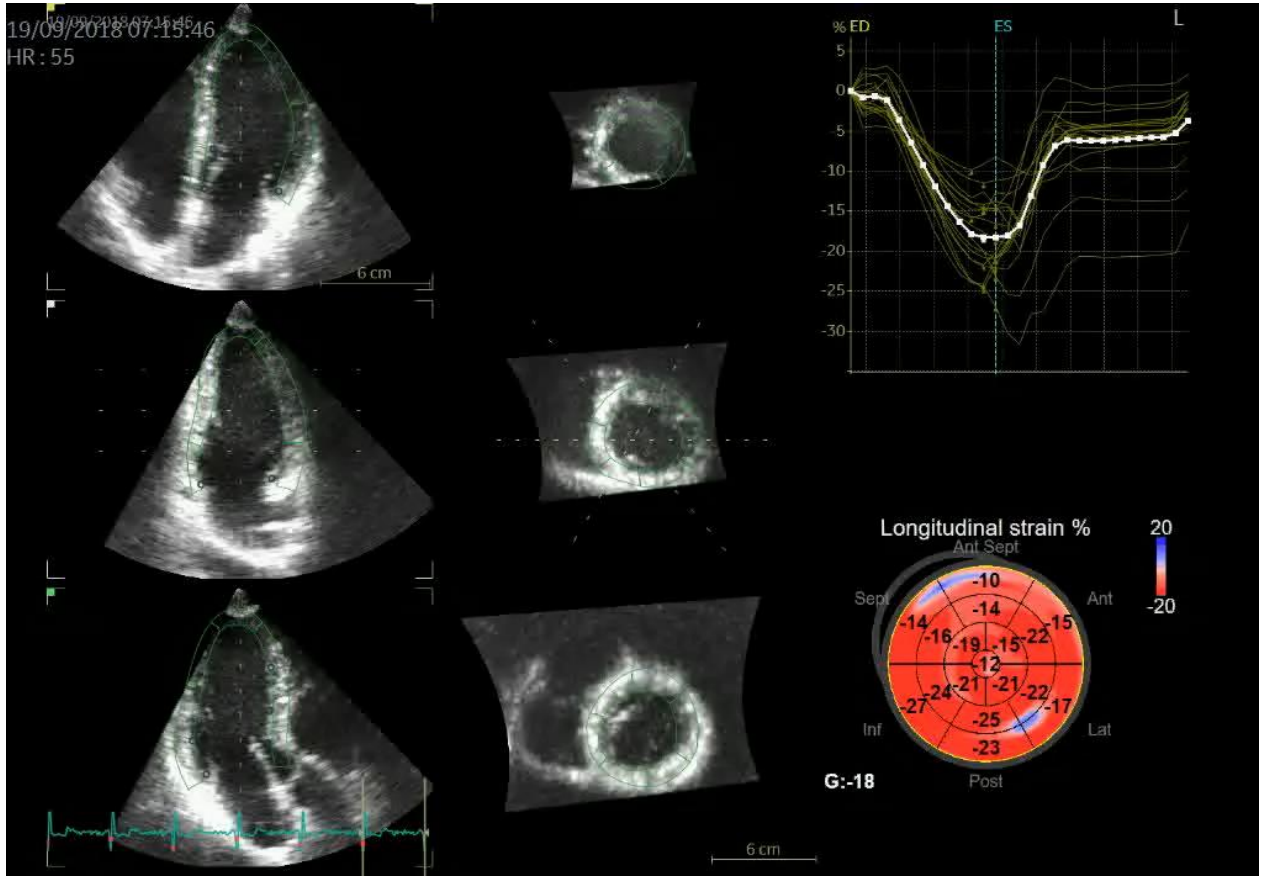
- **3D echocardiography** is feasible in majority of patients with Anderson-Fabry disease
- **3D global longitudinal strain** was the strongest predictor of heart failure severity measured by natriuretic peptide levels in multivariate analyses
- **3D regional circumferential strain** in posterolateral regions was associated with presence of myocardial scarring on cardiovascular magnetic resonance
- **3D global longitudinal strain** was significant predictor of long-term morbidity of patients with Anderson-Fabry disease while circumferential strain was not

Thank you for your attention.


VFN PRAHA

Three dimensional echocardiography: tracking examples





Images: General Teaching Hospital

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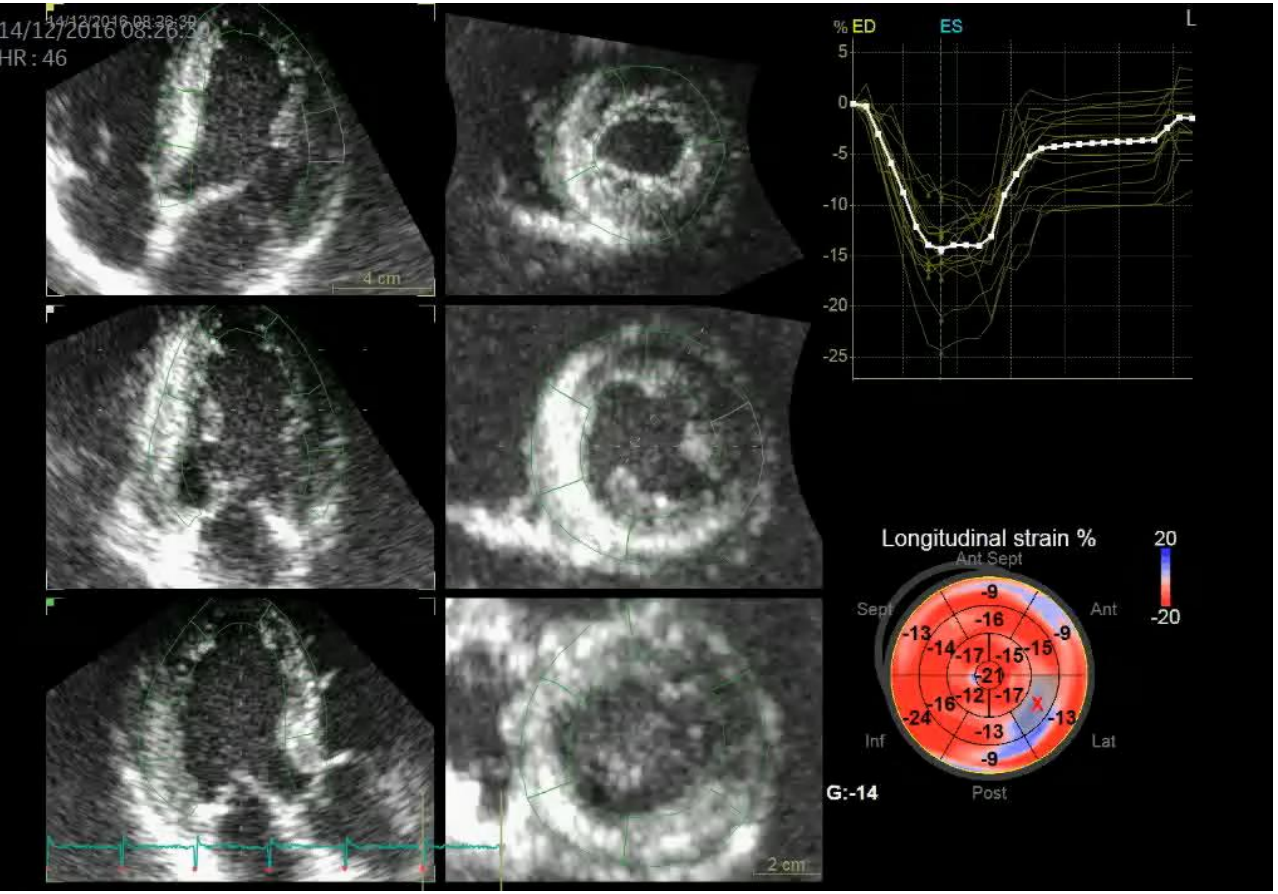

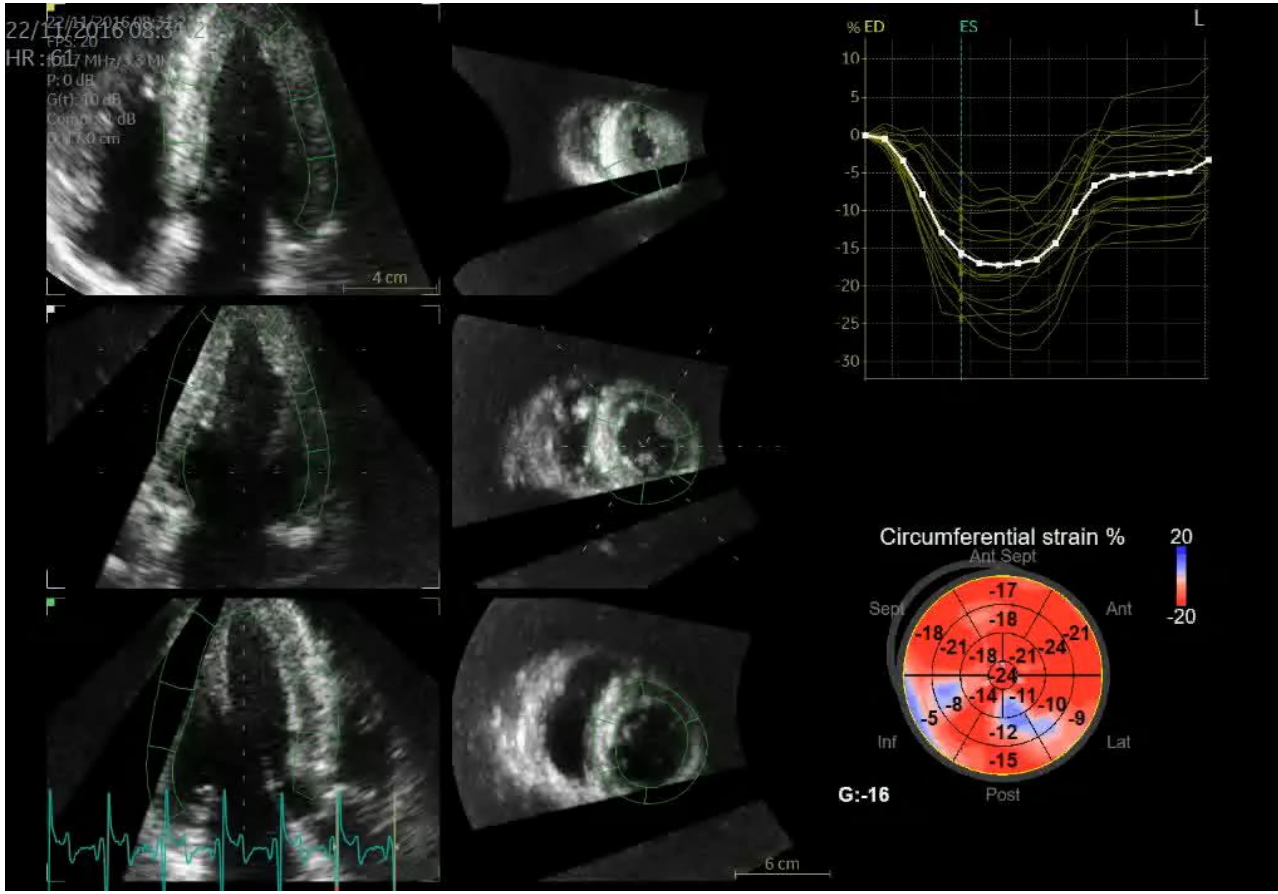

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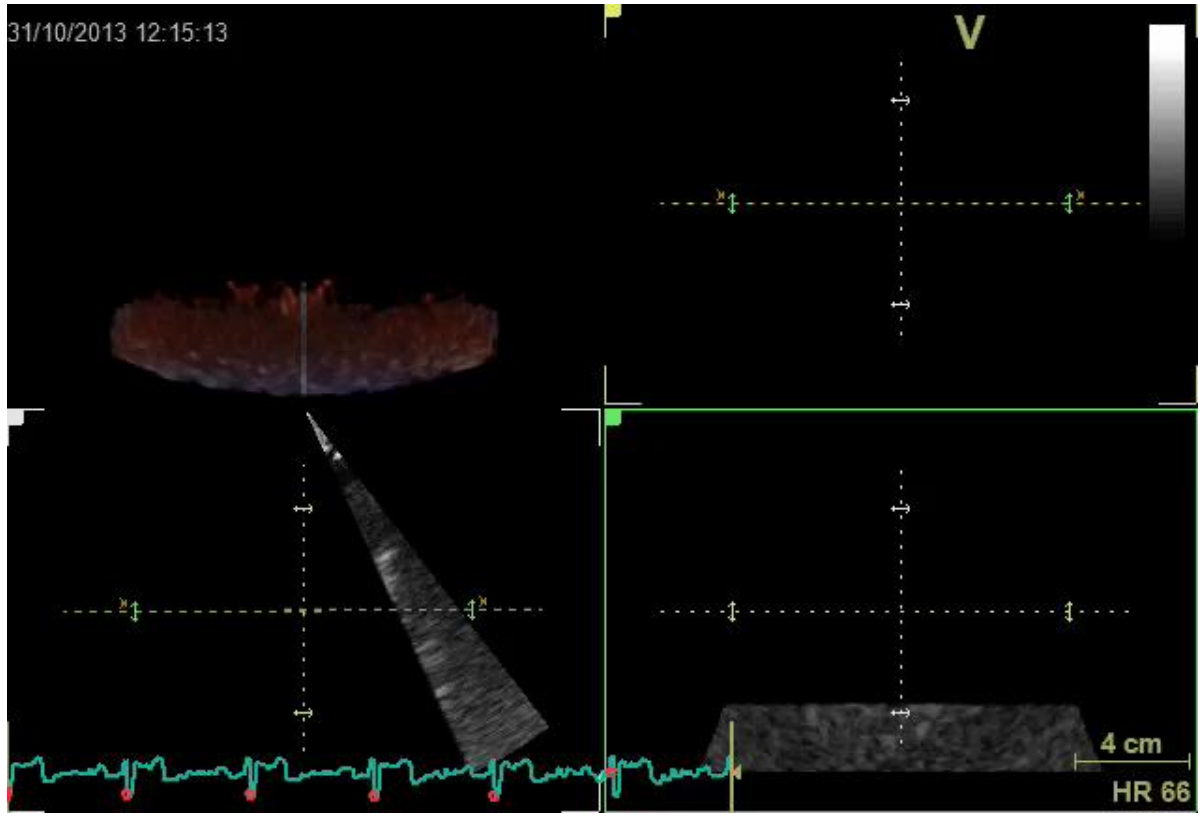

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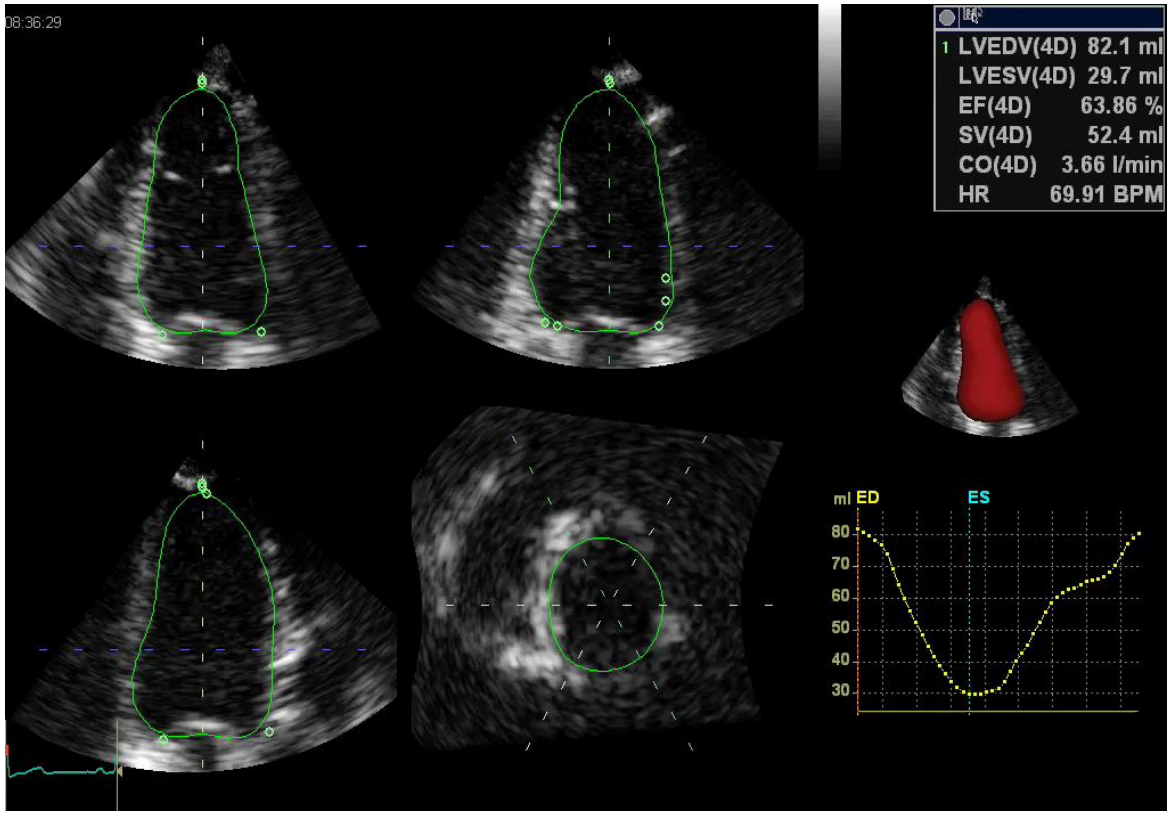

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