

**luncheon panel-cardiomiopatie rare,
cardiopatie neuromuscolari e malattia di anderson-fabry**

Risonanza magnetica cardiaca: valore diagnostico e prognostico

Antonia Camporeale, MD, PhD

Multimodality Cardiac Imaging Unit
IRCCS Policlinico San Donato



Honoraria for presentations and board meetings from
Amicus Therapeutics, Sanofi-Genzyme and Chiesi



- ✓ CMR in Fabry Disease: what are we talking about
- ✓ Diagnostic role of CMR in Fabry Disease
- ✓ Prognostic role of CMR in Fabry Disease
- ✓ The PSD experience in the field of Fabry Disease
- ✓ Take home messages



CMR in Fabry Disease



CMR in Fabry Disease: acquisition protocol



10 min

5 min

5 min

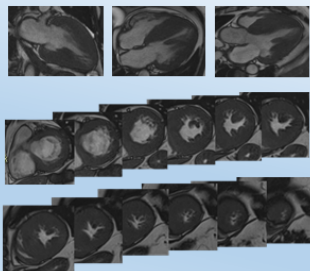


8-10 min wait + 10 min

5 min

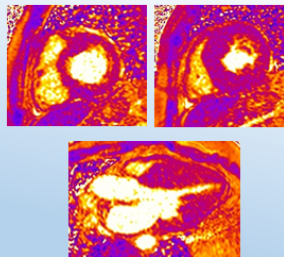
SEQUENCES

CINE SSFP



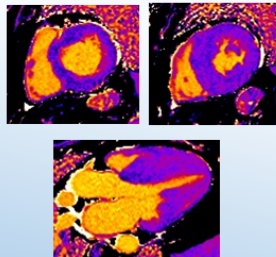
Quantification of LV/RV volumes,
function, mass

T2 MAPPING



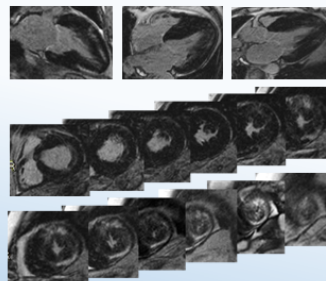
Presence and extent of
myocardial inflammation**

T1 MAPPING-PRE



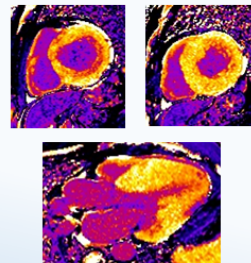
Presence and extent of
Gb3 storage***

LGE

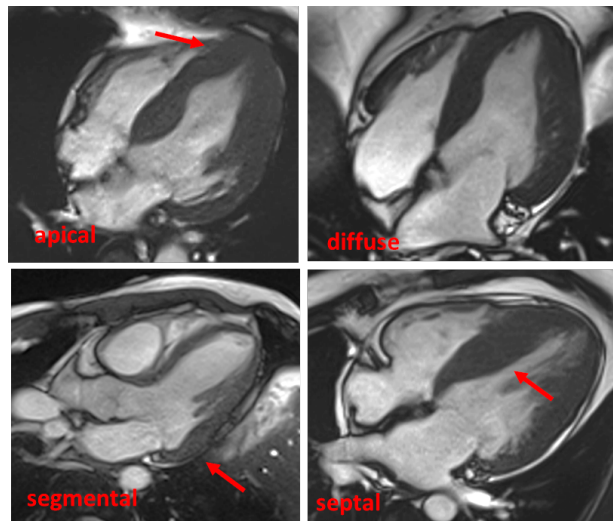


Increase in extracellular space****

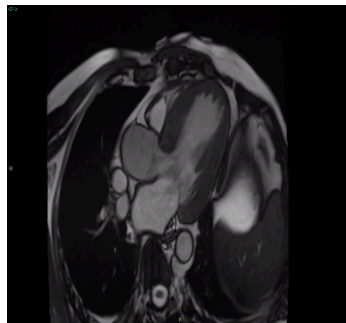
T1 MAPPING-POST



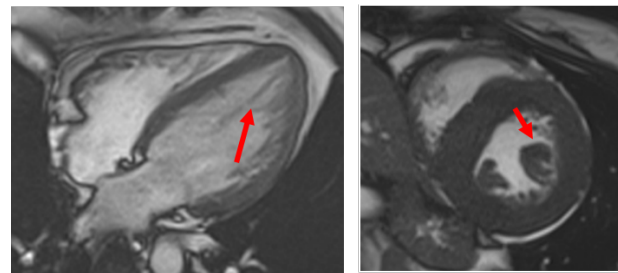
Pattern of LVH



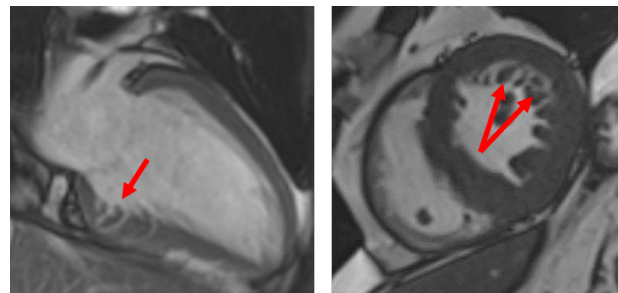
LVOTO



Anomalies of papillary muscles



Myocardial trabeculations, crypts

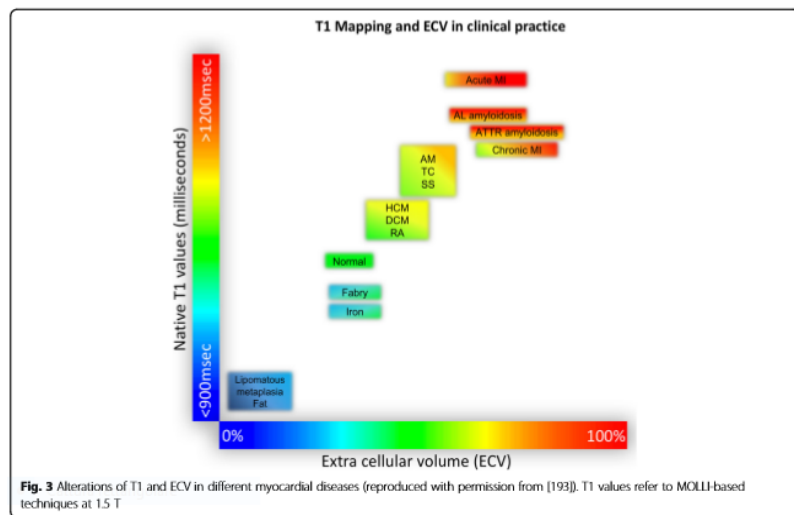


Courtesy of the speaker

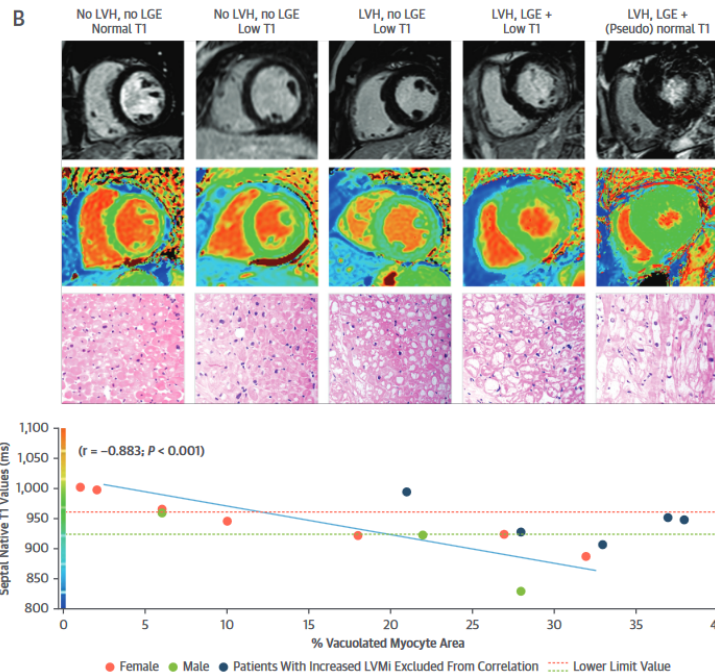


Native T1 (ms)

reflects myocardial disease involving the myocyte and interstitium



Messroghli et al. JCMR 2017



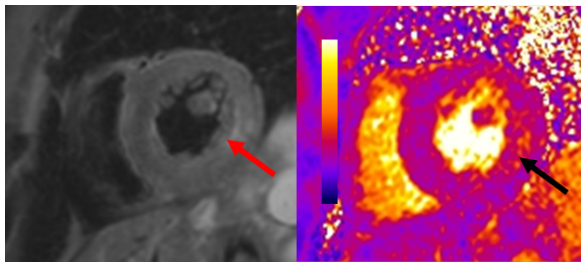
Ditaranto et al, JACC CV Imaging 2023



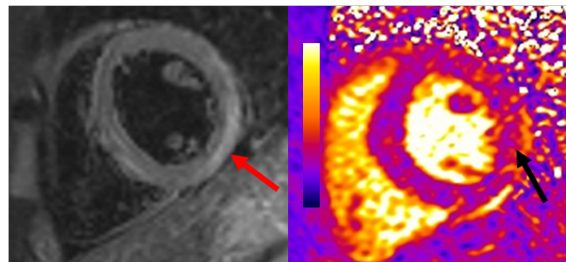
CMR in Fabry Disease: T2 mapping

T2 (ms)

reflects local myocardial inflammation and edema



Fabry Disease



Acute myocarditis

- ✓ T2 values are higher in FD than in other cardiomyopathies
- ✓ T2 values are associated with troponin levels, GLS impairment, and ECG abnormalities
- ✓ The increase in T2 values in FD is chronic

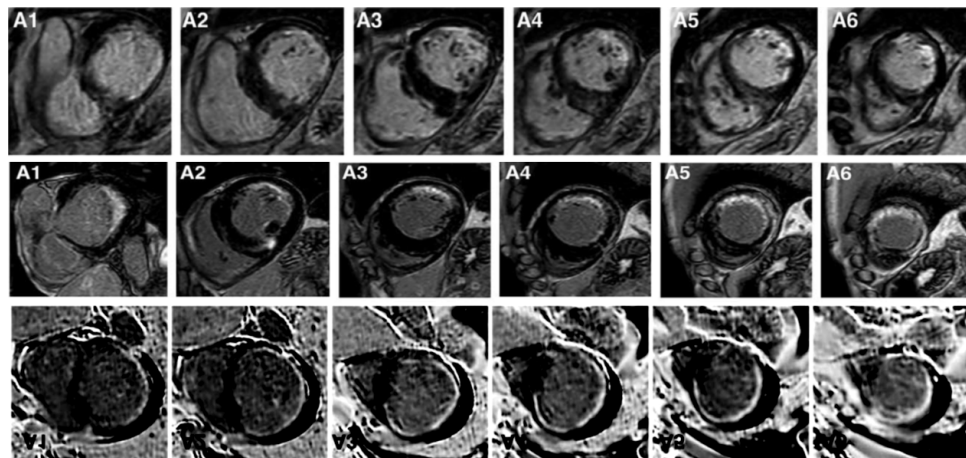
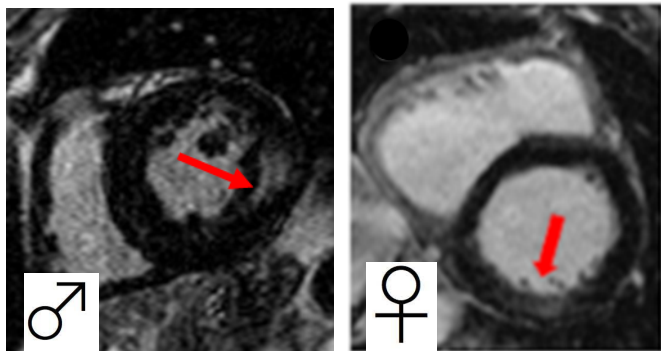
Nordin et al, J Am Coll Cardiol 2016

Augusto et al, Circ Cardiovasc Imaging. 2020;

Nordin et al, Circ Cardiovasc Imaging. 2019



- ✓ LGE= irreversible organ damage (edema and fibrosis)
- ✓ Different behaviour in male and female patients
- ✓ Typical/atypical pattern



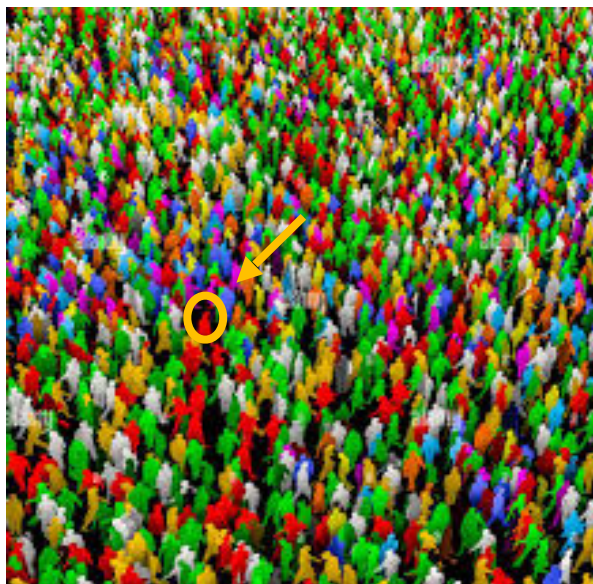
Ditaranto et al, Circ CV Imaging 2024



Diagnostic role of CMR in Fabry Disease

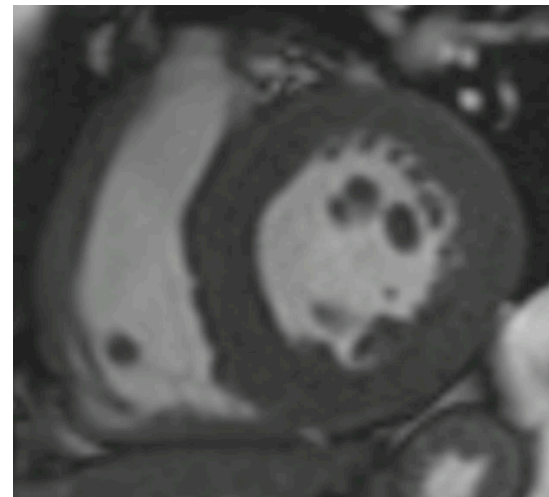
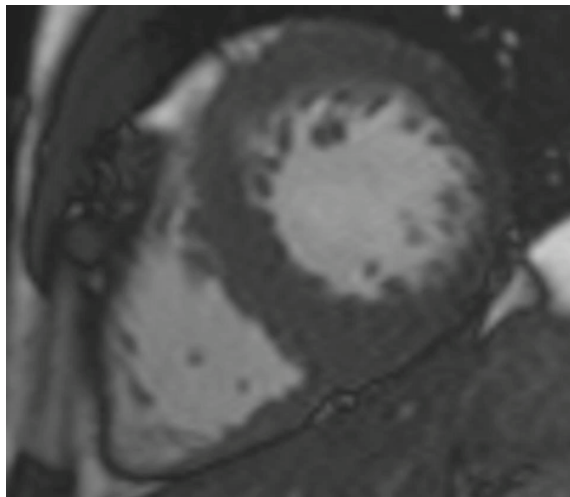
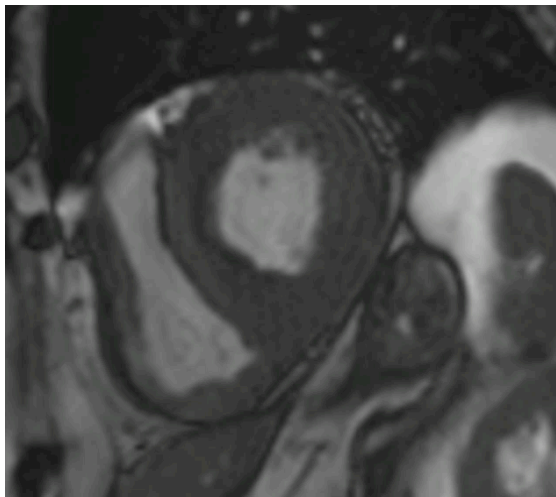


To detect **Fabry Disease** among patients with **other forms of LVH**



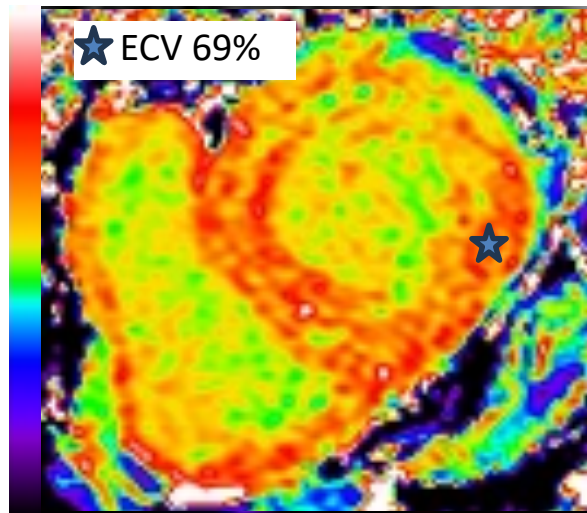
To detect **Cardiac Involvement** in patients with genetic diagnosis of **Fabry Disease**



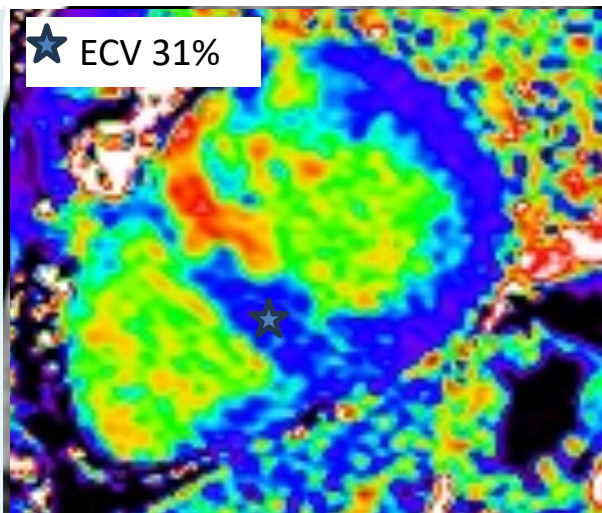


Courtesy of the speaker

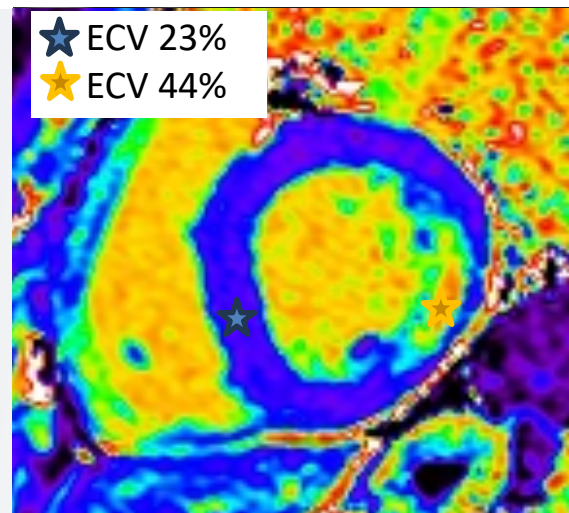




AMYLOIDOSIS



**HYPERTROPHIC
CARDIOMYOPATHY**



FABRY CARDIOMYOPATHY

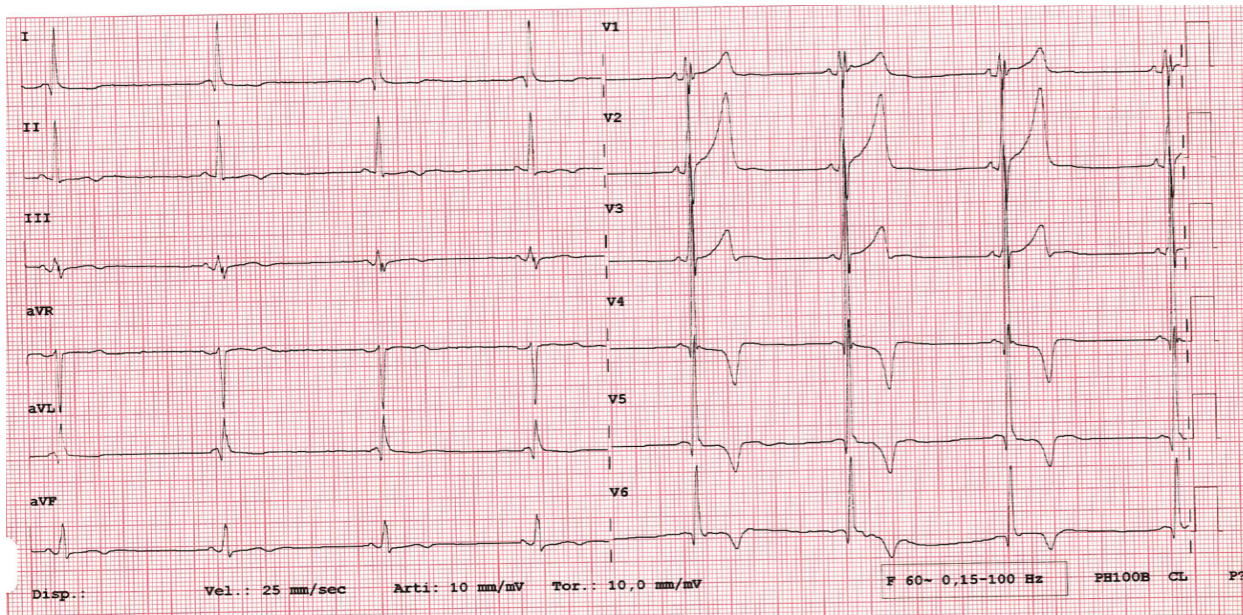
PSD reference values:

Native T1 1008 +/- 21 ms / ECV 27 +/- 2%

Courtesy of the speaker



M 52 y.o., p.R342X Exon 7
(nonsense mutation, classic form)



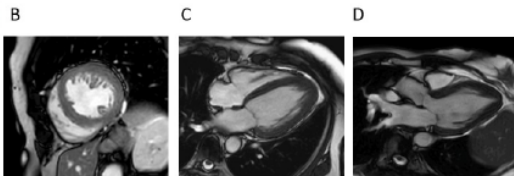
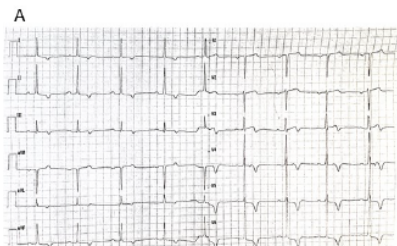
Previous kidney transplant, hypohidrosis, angiokeratomas



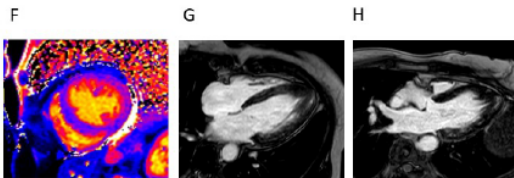
CARDIOVASCULAR IMAGES

Atypical Left Ventricular Remodeling in Fabry Cardiomyopathy: The Key Diagnostic Role of T1 Mapping

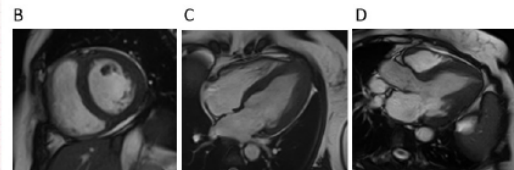
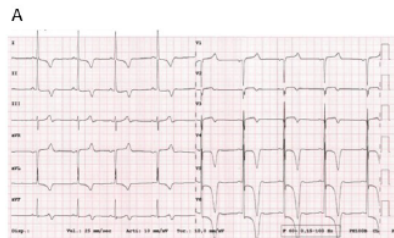
Stefano Censi¹, MD; Giada De Angelis², RN; Federico Pieruzzi³, MD, PhD; Lara Tondi, MD; Gianluigi Guida⁴, MD; Giandomenico Disabato⁵, MD; Andrea Attanasio⁶, MD; Pietro Spagnolo⁷, MD; Gianpaolo Carrafiello⁸, MD; Massimo Lombardi⁹, MD; Antonia Camporeale¹⁰, MD, PhD



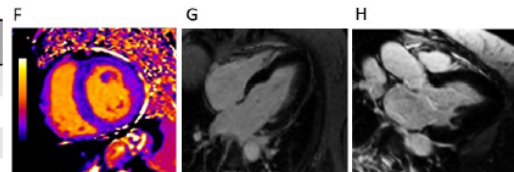
CMR parameter	Reference value
LV mass (g/m ²)	80 34-70
Septal T1 (ms)	938±22 1009±29
IL T1 (ms)	1105±31 1009±29
Septal ECV (%)	27 28±3
IL ECV (%)	36 28±3



F 64 y.o., p.Asn215Ser
(missense mutation, cardiac variant)

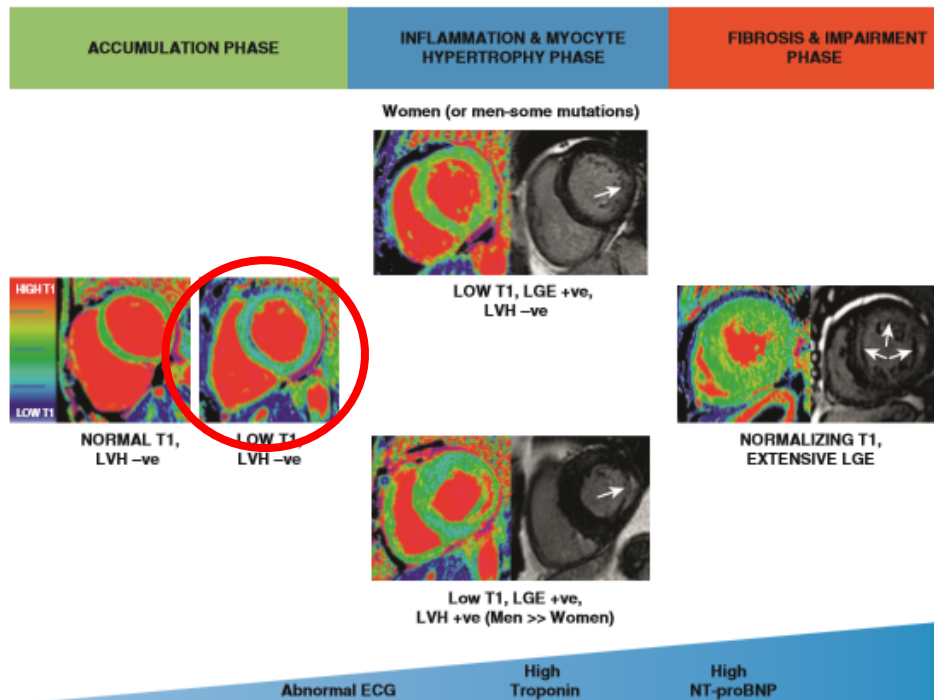


CMR parameter	Reference value
LV mass (g/m ²)	97,9 47-77
Septal T1 (ms)	857±34 1009±21
IL T1 (ms)	910±52 1009±21
Septal ECV (%)	25 27±2
IL ECV (%)	30 27±2



F 52 y.o., p.Asn215Ser
(missense mutation, cardiac variant)

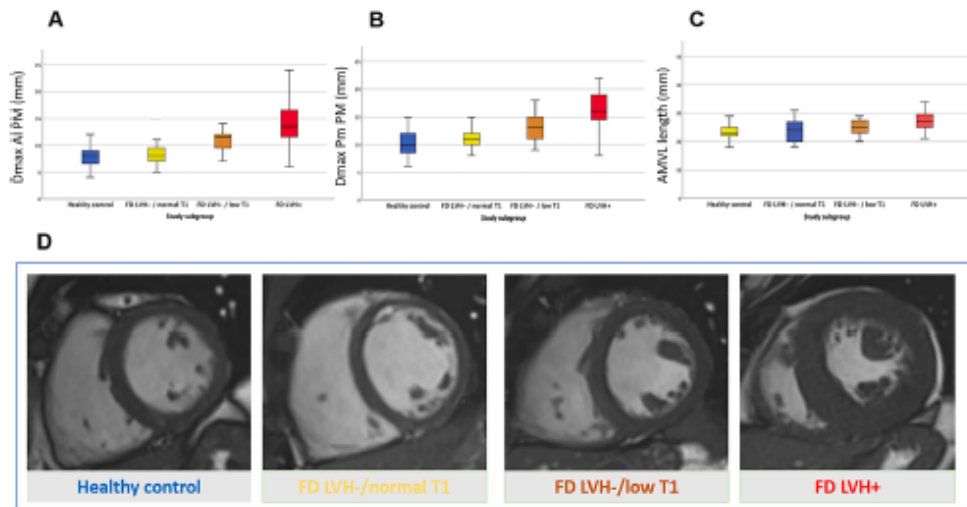
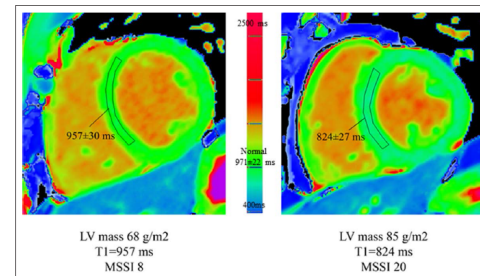




Nordin et al. JACC CV Imaging 2018



- ✓ Low T1 correlates with early ECG and morphological cardiac changes
- ✓ Low T1 is a risk factor for disease worsening at one year FU
- ✓ Atrial deformation is impaired in LVH –ve patients with low T1



Camporeale et al, *Circ CV Imaging*. 2019
Bernardini, Camporeale et al. *JACC: CV Imag* 2020
Figliozzi et al, *International J Cardiol* 2023
Camporeale et al, *European Heart J CV Imag* 2022
Tondi et al, *Front Cardiovasc Med*. 2024



Prognostic role of CMR in Fabry Disease



✓ LGE= poor response to ERT (Early treatment = better outcome)

✓ Negative prognostic factor

(H)

LGE Presence - Cardiovascular Endpoint

Study	Study Year	HR	Weight (%)
Hanneman	2020	7.00 [2.32, 21.15]	15.44
Hanneman	2020	7.20 [1.51, 34.28]	8.11
Tao	2020	1.71 [0.39, 7.49]	9.00
Osborne	2022	3.42 [1.81, 6.47]	39.40
Perera	2023	4.71 [1.98, 11.21]	23.78
Hiestand	2023	22.00 [2.49, 194.30]	4.26
Overall		4.45 [2.82, 7.02]	

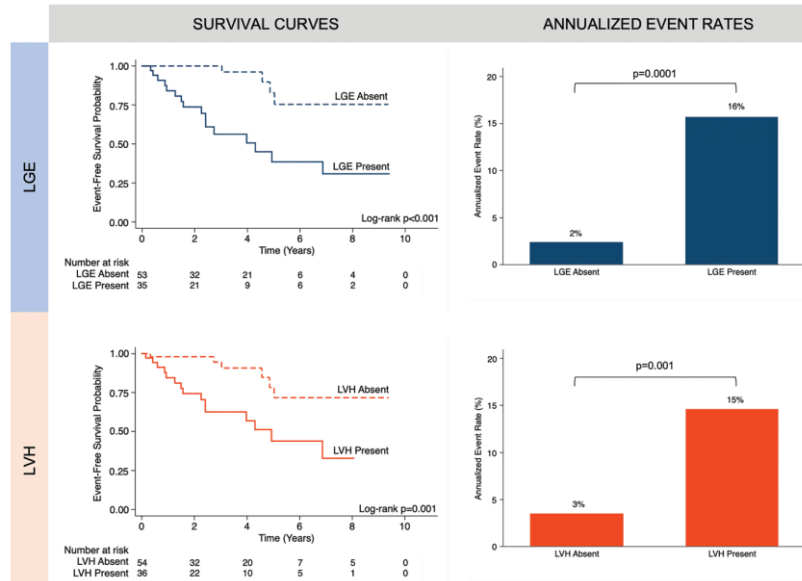
Heterogeneity: $\tau^2 = 0.03$, $I^2 = 8.95\%$, $H^2 = 1.10$

Test of $\theta_1 = \theta$: $Q(5) = 5.35$, $p = 0.37$

Test of $\theta = 0$: $z = 6.43$, $p = 0.00$

0.5 2 8 32 128

Random-effects empirical Bayes model



Stankowski K et al, Eur J Clin Invest 2025

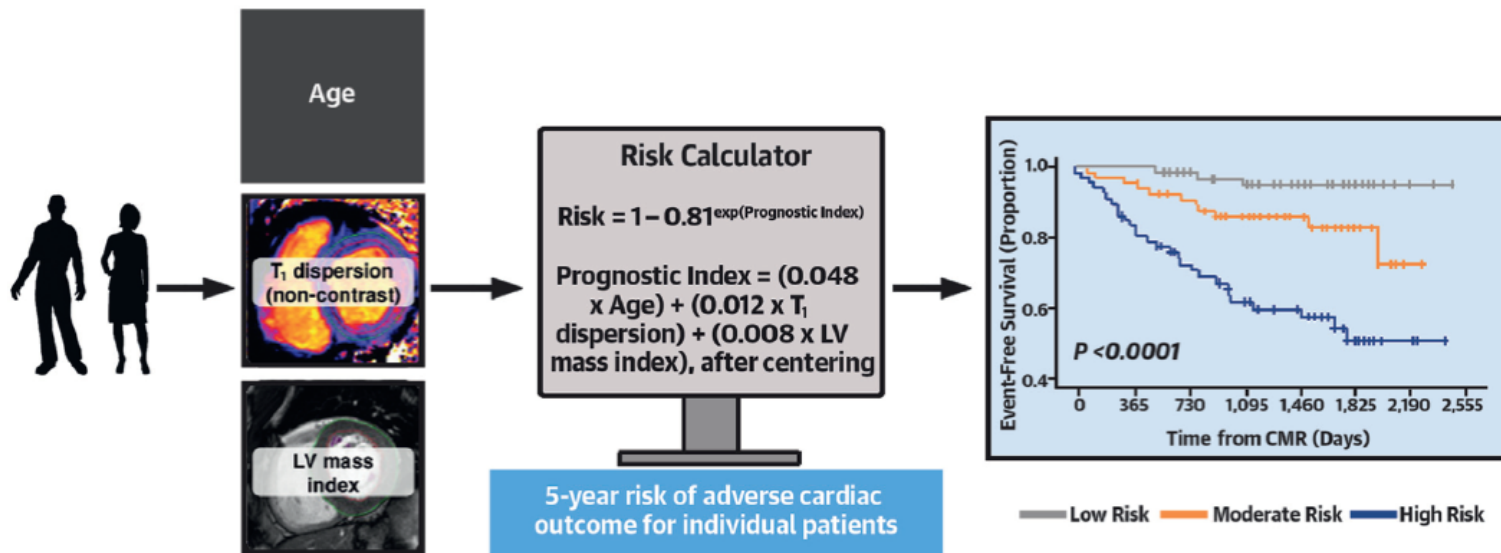
Hanneman et al, Radiology 2020

90 FD patients (65% F, mean age 44 y)

Median FU 3,6 y



Prognostic role of CMR in Fabry Disease

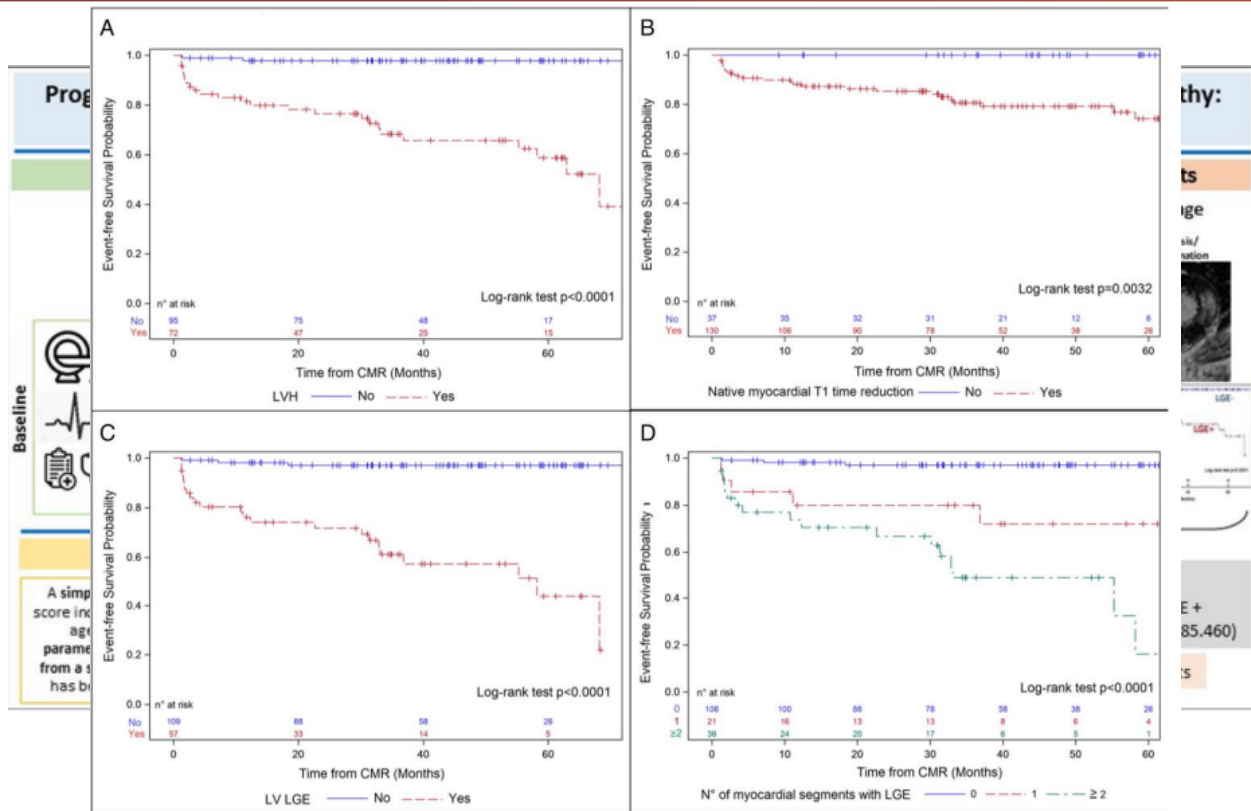


200 FD patients (60%F, mean age 46 y)

Median FU 4.5 y

Orsborne C, et al. J Am Coll Cardiol. 2022





Camporeale et al, EHJ QCCO 2026



Role of myocardial inflammation in the progression of Fabry cardiomyopathy: a multicentre cardiac magnetic resonance study

105 FD patients with at least 2 CMR
M 42%, F 58% Median Age 43 years

185 CMR pairs

LGE- at baseline

LGE+ at baseline

Group A

LGE- at FU

Group B

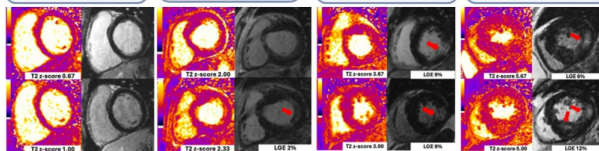
LGE+ at FU

Group C

LGE unchanged
at FU

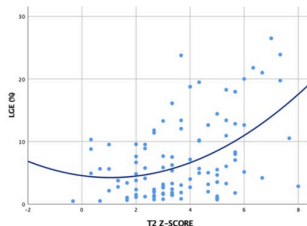
Group D

LGE increased
at FU



T2 z-score **OR 1.506** for LGE
appearance

T2 z-score **OR 6.417** for LGE
progression



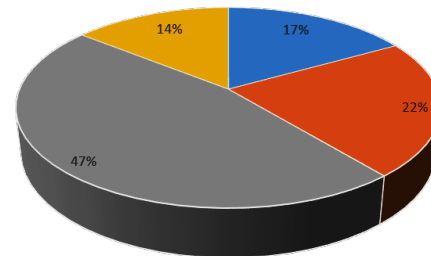
KEY MESSAGES

- Elevated T2 values emerged as an independent predictor of Fabry cardiomyopathy progression.
- A quadratic relationship exists between %LGE and T2 z-score
- These findings support the concept of FD cardiomyopathy as a chronic inflammatory condition, in which **inflammation plays a central role in sustaining myocardial damage.**

Functional capacity evaluation using cardiopulmonary testing and stress echocardiography in Anderson-Fabry Disease patients (OPTIMA-FD study)



Percentage of predicted-VO2 peak



■ Normal pVO2 ■ Mildly reduced ■ Moderate reduced ■ Severely impaired



CIRCLE - FD

CMR ITALIAN RESEARCH AND CLINICAL NETWORK
FOR FABRY DISEASE

Unpublished data



Schiavo et al, submitted

The PSD experience in the field of Fabry Disease





Contents lists available at [ScienceDirect](https://www.sciencedirect.com)

International Journal of Cardiology

journal homepage: www.elsevier.com/locate/ijcard



Impact of cardiac magnetic resonance on the clinical management of patients with Fabry disease: Data from the CMR Italian research and CLinical nETwork for Fabry disease (CIRCLE-FD)

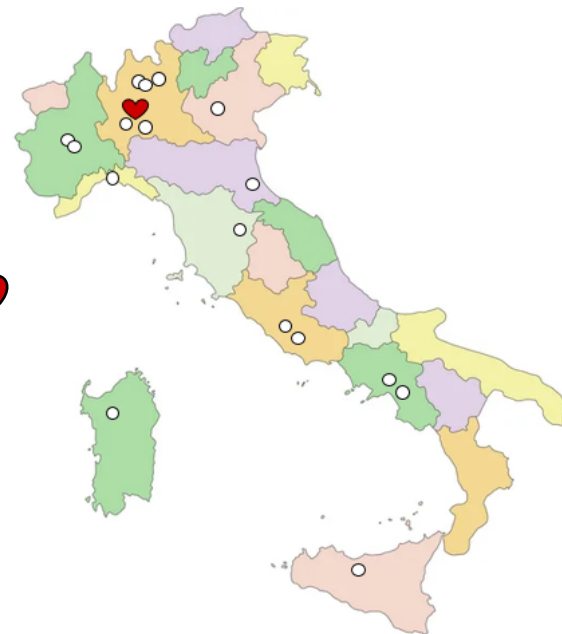
Antonia Camporeale^{a,b}, Giada De Angeli^c, Gianluigi Guida^{d,*}, Federico Pieruzzi^{e,f}, Laura Econimo^g, Paola Lusardi^h, Irene Motta^{i,j}, Renzo Mignani^k, Marco Spada^l, Maurizio Pieroni^m, Marco Canepa^{n,o}, Yuri Battaglia^{p,q}, Francesca Graziani^r, Marta Rubino^s, Sabrina Caruso^t, Stefania Piga^u, Chiara Lanzillo^v, Irene Simonetta^w, Corinna Antonia Inserra^x, Anna Bersano^y, Sara Boveri^z, Andrea Attanasio^d, Giandomenico Disabato^{a,d}, Lara Tondi^{a,b}, Pietro Spagnolo^{aa}, Massimo Piepoli^{d,ab}, Gianpaolo Carrafiello^{ac}, Massimo Lombardi^a



CIRCLE - FD

CMR ITALIAN RESEARCH AND CLINICAL NETWORK
FOR FABRY DISEASE

PROMOTING CENTER 
IRCCS Policlinico San Donato
20 PARTICIPATING CENTERS



2016-2025

250 FD patients
> 400 CMR scans

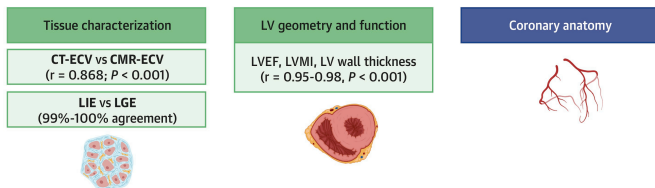
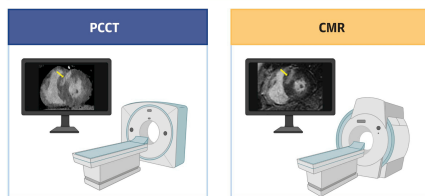
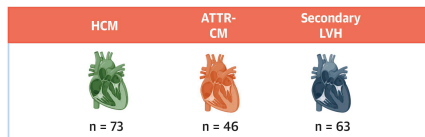


Future directions

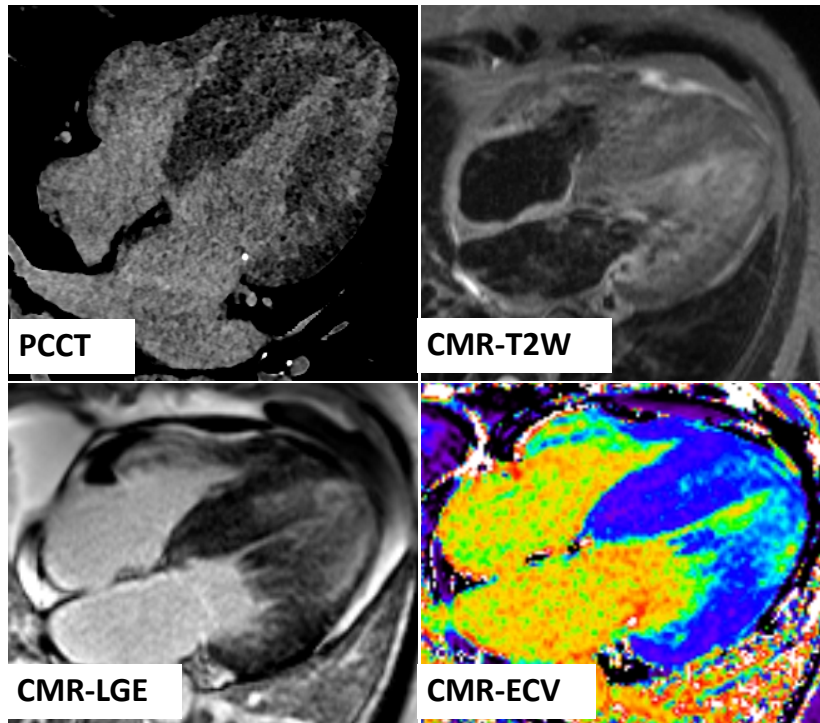


CENTRAL ILLUSTRATION: PCCT vs CMR in LVH: Agreement for Geometry/Function and Myocardial Tissue Characterization

Consecutive LVH cohort: n = 182
PCCT in all patients (coronary CTA + late iodine imaging + iodine maps/ECV)
PCCT + CMR: n = 83 ± 12 months (median interval 12 days)



De Gori C, et al. JACC Cardiovasc Imaging. 2026;10.1016/j.jcmg.2026.02.019



Courtesy of the speaker



Take Home Messages



- ✓ CMR is a powerful multiparametric imaging tool for the assessment of cardiac involvement in Fabry disease, supporting differential diagnosis, early detection and risk stratification
- ✓ Photon-counting CT may represent a valuable imaging modality to be integrated into the assessment of cardiac involvement in Fabry disease+
- ✓ Imaging studies must be guided by clinical evaluation and integrated with clinical data



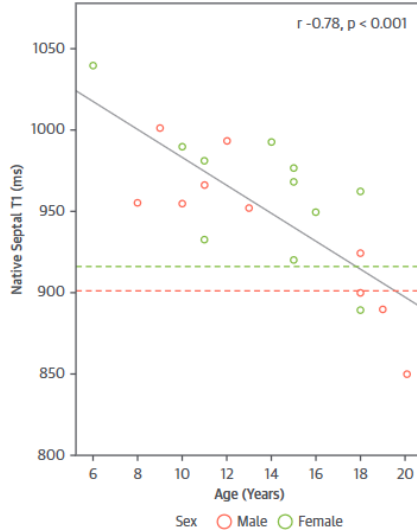
UNIVERSITÀ
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Thanks for your attention





Non of the 15 pediatric patients included showed low T1 values

Nordin et al. JACC CV Imaging 2018



Contents lists available at [ScienceDirect](https://www.sciencedirect.com)

Molecular Genetics and Metabolism Reports

journal homepage: www.elsevier.com/locate/ymgmr

Use of T1 mapping in cardiac MRI for the follow-up of Fabry disease in a pediatric population[☆]

Oscar Werner^{a,b,*}, Lydia Ichay^c, Nabila Djouadi^c, Fernando Vetromile^e, Marie Vincenti^a, Sophie Guillaumont^a, Dominique P. Germain^d, Marc Fila^c

Out of the six patients included, (3 males), low T1 values were observed in 4 patients

Werner et al, 2024

