

WALKING POSTER PRESENTATION

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# Extracellular volume fraction correlates with myocardial stiffness and allows for differentiation between impaired active relaxation and passive stiffness in heart failure with preserved ejection fraction

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## Background

Optimal patients characterization in Heart Failure with Preserved Ejection Fraction (HFpEF) is essential to tailor successful treatment strategies.

Cardiac magnetic resonance derived T1-Mapping allows for non-invasive quantification of diffuse myocardial fibrosis as extracellular volume fraction (ECV).

We aimed to elucidate the diagnostic performance of T1-Mapping in HFpEF by examining the relationship between ECV and invasively measured parameters of diastolic function and investigated the potential of ECV to differentiate between different pathomechanisms in HFpEF.

## Methods

We performed T1-Mapping in 21 patients with HFpEF and 11 patients without heart failure symptoms. Pressure-volume-loops were obtained with a conductance catheter during basal conditions and handgrip exercise. Transient preload reduction was used to extrapolate the diastolic stiffness constant.

## Results

Patients with HFpEF showed a higher ECV ( $p = 0.001$ ), an elevated load-independent passive LV-stiffness-constant  $\beta$  ( $p < 0.001$ ) and a longer time constant of active LV-relaxation  $\tau$  ( $p = 0.04$ ). ECV correlated highly

with  $\beta$  ( $r = 0.75$ ,  $p < 0.001$ ). After multivariate analysis, ECV remained the only independent predictor of  $\beta$ .

Within the HFpEF cohort, patients with ECV  $>$  median showed a higher LV-stiffness-constant ( $p = 0.05$ ) whereas ECV  $<$  median identified patients with a prolonged active LV-relaxation ( $p = 0.01$ ) and a marked hypertensive reaction to exercise due to a pathologic arterial elastance ( $p = 0.05$ ).

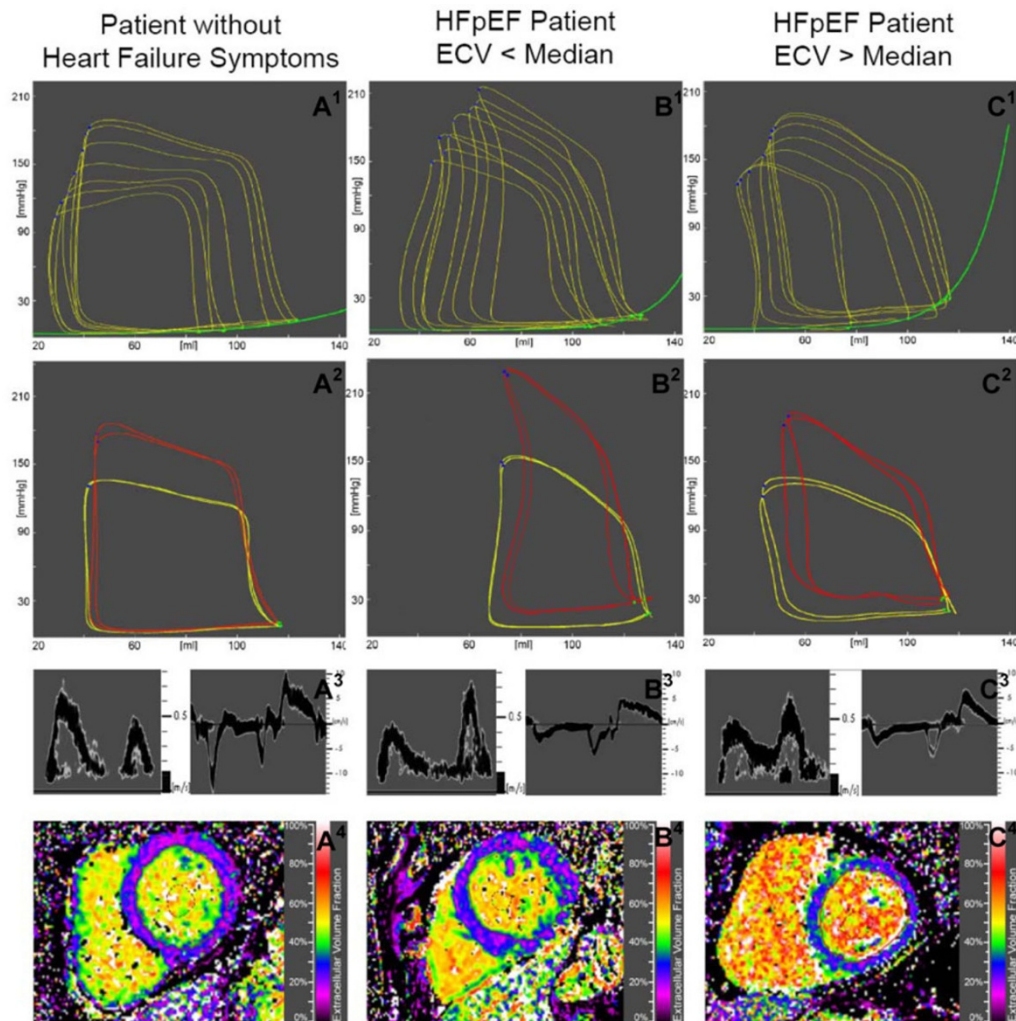
## Conclusions

Diffuse myocardial fibrosis, assessed by CMR derived T1-Mapping, independently predicts invasively measured LV stiffness in HFpEF. In addition, ECV helps to non-invasively distinguish the role of impaired active relaxation and passive stiffness. It also refines characterization of patients, which represents a prerequisite for any successful therapy in the future.

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- (A) Patient without HF symptoms 1: Pressure-volume loops under transient preload reduction show a shallow slope of the EDPVR line (green line). 2: Pressure-volume loops at baseline (yellow) and throughout exercise (red) with physiologic response to exertion and a small change in EDPVR (green points) 3: Echocardiographic assessment of MV inflow pattern (left) and septal MV annular velocities (right) with no evidence of diastolic dysfunction. 4) CMR-derived T1-Mapping with native T1-Map (left) and ECV-Map for 3 slices (right) demonstrating a low ECV of 25%.
- (B) HFpEF patients with  $ECV < Median$  (B) 1: Pressure-volume loops under transient preload reduction shows an increased slope of the EDPVR line (green line). 2: Pressure-volume loops at baseline (yellow) and throughout exercise (red) with elevated arterial elastance and marked hypertensive response to exertion resulting in significant change in EDPVR (green points) 3: Echocardiographic assessment of MV inflow pattern (left) and septal MV annular velocities (right) shows diastolic dysfunction. 4) CMR-derived T1-Mapping with native T1-Map (left) and ECV-Map for 3 slices (right) demonstrating an ECV of 31%.
- (C) HFpEF patients with  $ECV \geq Median$  1: Pressure-volume loops under transient preload reduction shows the steepest slope of the EDPVR line (green line). 2: Pressure-volume loops at baseline (yellow) and throughout exercise (red) with significant change in EDPVR (green points) 3: Echocardiographic Assessment of Mitral valve inflow pattern (left) and septal mitral valve annular velocities (right) shows diastolic dysfunction without notable different to B<sup>3</sup>. 4) CMR-derived T1-Mapping with native T1-Map (left) and ECV-Map for 3 slices (right) demonstrating an ECV of 36%.

CMR= cardiac magnetic resonance, ECV= Extracellular Volume fraction, EDPVR=End-diastolic pressure volume relation, HF=Heart Failure, HFpEF= Heart Failure with preserved ejection fraction, LV=left ventricular, MV=mitral valve.

**Figure 1** Results of pressure volume analysis, echocardiography and CMR-imaging according to ECV group and controls.