Comparison of extravascular volume by cardiac MR T1 mapping by conventional look locker versus modified look locker techniques to predict histologically measured fibrosis in valve disease.

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Background

• Chronic **valvular disease** is associated with left ventricular (LV) remodeling and apparition of diffuse **interstitial fibrosis.**

• **Histopathology** is the gold standard for evaluating diffuse myocardial fibrosis.

• Cardiac Magnetic Resonance (CMR) **T1 mapping** was proposed as a new method to non invasively quantify diffuse myocardial fibrosis by measuring the **myocardial extracellular volume** (ECV) with a conventional look locker (LL) or a T1 modified look locker (MOLLI) CMR sequence.

Aim of the study:

To compare LL and MOLLI against histological measurement of fibrosis.

Methods

Patient population

• Patients with isolated severe chronic valve disease (aortic stenosis, aortic or mitral regurgitation), no angiographically coronary artery disease and a planned surgery for correction of the valvulopathy (table 1).

• No contraindication to MRI and written inform consent, approved by the local ethics committee.

Left Ventricular Biopsy

• Anterior apical LV transmural biopsies were acquired during cardiac valve surgery.

• Biopsies were fixed in 10% buffered formalin, embedded in paraffin and stained with picrosirius red.

• Quantification was performed using an automated image analyze system after elimination of perivascular fibrosis (fig 1).

• Collagen was expressed as a percentage of total endomyocardial area.

T1 evaluation by CMR Conventional Look Locker

• During pre-operative CMR, conventional LL sequence was acquired 10 minutes after gadolinium-based contrast administration.

• Segment software was used to compute the T1 map (Fig 2). ROI's were placed on the antero-septal myocardial segment and in the blood pool. T1 was obtained pixel by pixel and fitted T1 by extrapolation.

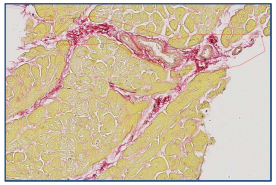


Fig 1: Picrosirius red staining on LV biopsy.

Table 1: Patient population

N=36 patients	Mean ± SD
Age (years)	52± 22
Male Gender (n, %)	27 (75)
Aortic stenosis (n, %)	14 (38)
Aortic regurgitation (n, %)	11 (31)
Mitral regurgitation (n, %)	11 (31)

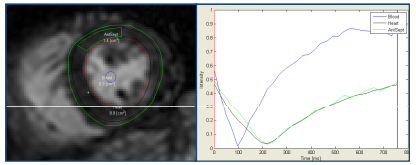


Fig 2: Example of T1 mapping calculation. Left: endocardial, epicardial contours and ROI's traced on the LL sequence, right: T1 fitted curve..

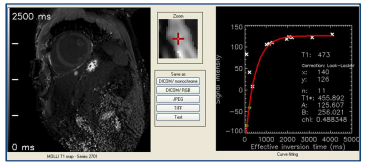


Fig 3: Example of T1 mapping calculation. Left: MOLLI sequence corrected for respiratory motion, middle: zoom-in of the myocardial septal wall, right: T1 fitted curve.

T1 evaluation by CMR Modified Look Locker

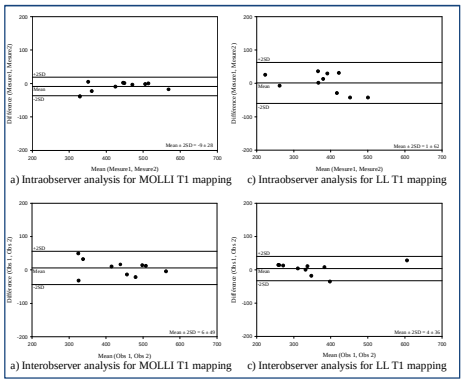
• MOLLI sequence (5-3-3) was acquired before and 25 to 30 minutes after gadolinium-based contrast administration.

• MR Map software was used to compute the T1 map (Fig 3). Respiratory motion correction was performed whenever necessary.

ECV evaluation by CMR T1 mapping

$$\mathbf{ECV} = (1\text{-Hc})^{*} \frac{((1/T1)_{myo\text{-}post} - (1/T1)_{myo\text{-}pre})}{((1/T1)_{blood\text{-}post} - (1/T1)_{blood\text{-}pre})}$$

Results



a) Intraobserver analysis for MOLLI T1 mapping c) Intraobserver analysis for LL T1 mapping

a) Interobserver analysis for MOLLI T1 mapping c) Interobserver analysis for LL T1 mapping

Fig 4: Intra- (up) and inter- (down) observer analysis. On MOLLI sequence in left and on look locker sequence in right

Intra - and inter-observator analysis of T1

• Inter- and intra-observator variability of LL and MOLLI was tested on 10 patients (fig 4).

N=36 patients	Mean ± SD
MOLLI sequence	
T1 mapping (ms)	390 ± 36
ECV (%)	29.1 ± 5.2
Look locker sequence	
T1 mapping (ms)	402 ± 108
ECV (%)	27.8 ± 8.7
Fibrosis (%)	5.7 ± 4.1

Histological mesurement and ECV

• Amount of fibrosis on biopsy was 5.7 ± 4.1 [2.1;21].

• ECV by MOLLI T1 mapping was 29.1 ± 5.2% [21.7;47.0].

• ECV by LL T1 mapping was 27.8 ± 8.7% [16.4;52.5].

• Good correlation between histologically measured fibrosis and ECV MOLLI T1 mapping (r=0.75, p<0.001) but not for ECV LL T1 mapping (r=0.10, p=0.57, fig 5).

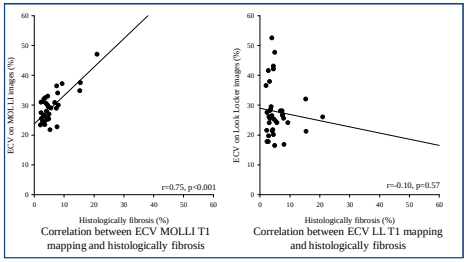


Fig 5: ECV by T1 mapping versus fibrosis

Conclusion

• ECV determined by CMR MOLLI T1 mapping closely correlates with histologically determined diffuse interstitial fibrosis.

• By contrast the LL method does not provide accurate measurement of ECV.

No disclosure