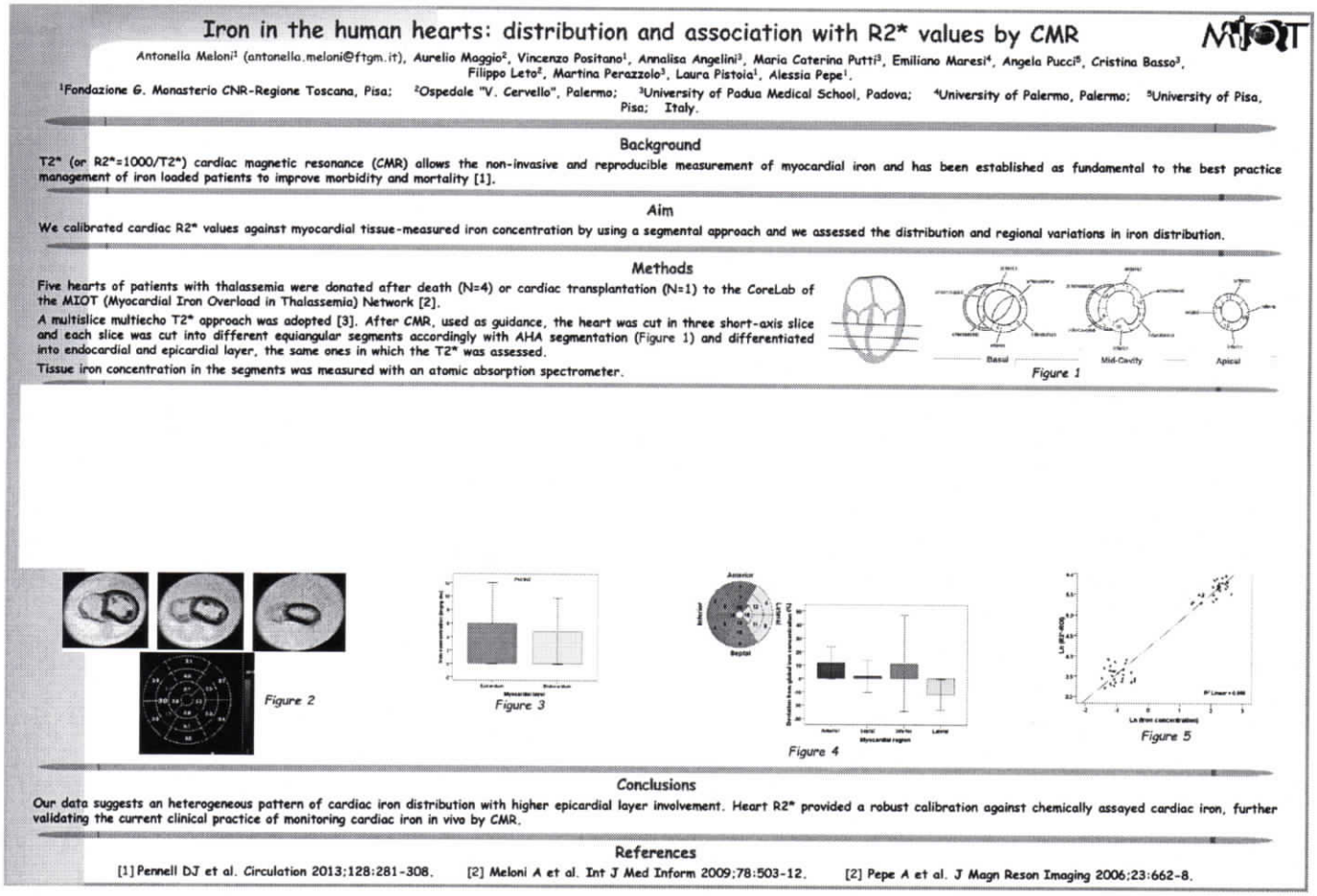

Iron in the human hearts: distribution and association with R2* values by CMR

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Background

T2* (or R2*=1000/T2*) cardiac magnetic resonance (CMR) allows the non-invasive and reproducible measurement of myocardial iron and has been established as fundamental to the best practice management of iron loaded patients to improve morbidity and mortality [1].

Aim

We calibrated cardiac R2* values against myocardial tissue-measured iron concentration by using a segmental approach and we assessed the distribution and regional variations in iron distribution.

Methods

Five hearts of patients with thalassemia were donated after death (N=4) or cardiac transplantation (N=1) to the CoreLab of the MIOT (Myocardial Iron Overload in Thalassemia) Network [2].

A multislice multiecho T2* approach was adopted [3]. After CMR, used as guidance, the heart was cut in three short-axis slice and each slice was cut into different equiangular segments accordingly with AHA segmentation (Figure 1) and differentiated into endocardial and epicardial layer, the same ones in which the T2* was assessed.

Tissue iron concentration in the segments was measured with an atomic absorption spectrometer.

Figure 1

Figure 2

Figure 3

Figure 4

Figure 5

Conclusions

Our data suggests an heterogeneous pattern of cardiac iron distribution with higher epicardial layer involvement. Heart R2* provided a robust calibration against chemically assayed cardiac iron, further validating the current clinical practice of monitoring cardiac iron in vivo by CMR.

References

[1] Pennell DJ et al. Circulation 2013;128:281-308. [2] Meloni A et al. Int J Med Inform 2009;78:503-12. [2] Pepe A et al. J Magn Reson Imaging 2006;23:662-8.

Abstract

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Results

55 samples were used since it was possible to analyze all the 16 samples only from two hearts due to medical-forensic reasons. The mean iron concentration in all samples was 4.71±4.67 mg/g dw. Segmental iron levels ranged from 0.24 to 13.78 mg/g dw. Mean iron concentration was significantly higher in the epicardial than in the endocardial layer (5.99±6.01 mg/g dw vs 4.84±4.87 mg/g dw; P=0.042).

The coefficient of variability (CoV) of iron for myocardial segments ranged from 8.08% to 24.54%, with a mean value for all patients of 13.49±6.93%. Four different main circumferential regions (anterior, septal, inferior and lateral) were defined. A circumferential heterogeneity was noted, with more iron observed in the anterior region, followed by the inferior region. The heterogeneity in circumferential iron concentration expressed as percentage deviation of the regions from the global value is shown in the Figure 1A.

A strong linear correlation (R-square=0.956) was found by plotting ln(R2*-ROI) and ln[Fe] with a slope s=0.654 (95% confidence intervals-CI=0.616-0.693) and intercept i=4.216 (95% CI=4.150-4.281) (Figure 1B). The linear relation was converted to the calibration curve: $[Fe] = 0.001591 \times (R2^*)^{1.529}$.