Myocardial Iron Distribution in Thalassemia: An In Vivo Study with Black Blood T2* Imaging

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Introduction

Cardiac complications secondary to iron overload are the leading cause of death in thalassemia major (TM). Cardiac magnetic resonance T2* techniques allow non-invasive and reproducible quantification of myocardial iron (1,2,3), which can improve diagnosis and monitor patient treatment. The recent advance of a black blood T2* technique (4) further improved the reproducibility and accuracy of the measurement. With black blood preparation high contrast images can be obtained with clearly defined myocardial borders, which assists researching of iron distribution across the myocardium. It is understood that iron accumulates in the ventricular septum and the free wall as well (5), with a tendency to be more concentrated in the epicardial layers (6,7,8). Nevertheless, only autopsy studies have been conducted due to sampling limitations, and an *in vivo* study has hitherto not been reported. In this study, therefore, we aim to investigate this phenomenon *in vivo* in a non-invasive way by use of the black blood T2* technique.

Material and Methods

In total 55 iron overloaded TM patients (26 females, mean age of 24±14 years) were scanned on a 1.5T MRI scanner (Siemens Sonata) in London using the breath-hold black blood T2* sequence (4). In brief, a cardiac phased array coil was used and a single mid-ventricular short axis slice was imaged at eight echo times with ECG gating. The echo times rang from 1.5ms to 16.9ms with an increment of 2.2ms. A region of interest (ROI) was drawn in the left ventricular septum for T2* measurement. *The mono exponential* decay model was used with an equation of $SI = P_0 \cdot e^{-TE/T2^*}$, where P_0 is a constant of magnetization, *TE* the echo time and *SI* the signal intensity. The Levenberg-Marquardt method of nonlinear curve fitting was employed for this study. Summary data are displayed graphically using scatter plots with the line of identity. All the T2* measurements were carried out using Thalassemia-Tools software (Cardiovascular Imaging Solutions, London). The study was approved by the local ethics committee and all patients gave informed consent.

Results

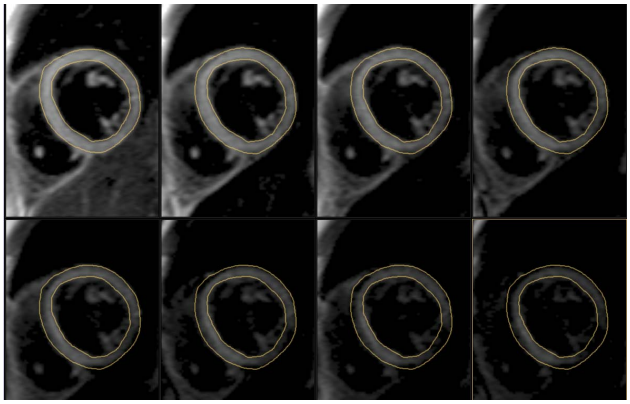

Figure 1 shows a typical example of 8 gradient echo images (first TE of 1.5ms and last 16.9ms, from top left to right bottom) obtained using the black blood T2* technique. There is no obvious difference between epi- and endomyocardial signal in the septum in the first echo image of 1.5ms. However, it demonstrates clearly that the epimyocardial signal in septum decays rapidly and diminishes to nearly noise in the last echo image. On the contrary, endomyocardial signal can still be clearly observed in the last echo image. In gradient images, iron deposition induces signal loss. Therefore, it suggests that there is a gradient of iron distribution from endo- to epimyocardium. This phenomenon was clearly observed on 45 of all 55 patients studied (T2*=10.3±7.9ms).

Figure 1. A typical example of mid-ventricular images at 8 different echo times from a TM patient.

Discussion and Conclusions

This is the first *in vivo* study to demonstrate that myocardial iron deposition in TM patients is uneven and dominantly in the epimyocardial region. This finding agrees well with the previous published autopsy reports (5-8). This finding suggests that T2* measurement should use large and transmural ROIs to be representative of the uneven distribution of iron deposition.

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