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A breath-hold R2 mapping pulse sequence detects a decrease in myocardial ferritin iron after one-week of iron chelation

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Introduction

In transfusional iron overload, almost all the excess iron is sequestered intracellularly as *ferritin iron*, a dispersed, soluble and rapidly mobilizable fraction, and *hemosiderin iron*, an aggregated, insoluble fraction that is a long-term reserve. The effective transverse relaxation rate (R_2*) of myocardium is predominantly influenced by hemosiderin iron and, even with intensive iron-chelating therapy, changes only slowly over several months [1]. Intracellular ferritin iron is evidently in equilibrium with the low molecular weight cytosolic iron pool [2] that can decrease rapidly with iron chelation. We propose to use a new breath-hold fast spin-echo (FSE) [3] pulse sequence that permits calculation of RR_2 [4], a "reduced transverse relaxation rate" as a measure of myocardial ferritin iron that is largely independent of hemosiderin iron.

Purpose

To use RR_2 measurements to detect short-term changes in myocardial ferritin iron produced by iron-chelating therapy.

Methods

We imaged 10 patients with thalassemia major (New York; mean age = 26.9 ± 10.3 years) on a 1.5 T MR scanner (Siemens-Avanto), and another 8 patients with thalassemia (Hong Kong; mean age = 29.3 ± 8.6 years) on a 3 T scanner (Phillips-Achieva). Both sets of patients were imaged in a mid-ventricular short-axis plane of the heart at mid-diastole, initially after discontinuing iron-chelation for one week, and subsequently after resuming their usual therapy (group 1: deferasirox; group 2: deferoxamine and/or deferiprone), for one week. Three different sets of FSE data were acquired in separate breath-holds with different echo spacings (ESP). For details on the pulse sequence and its parameters, please see references [3,5]. A

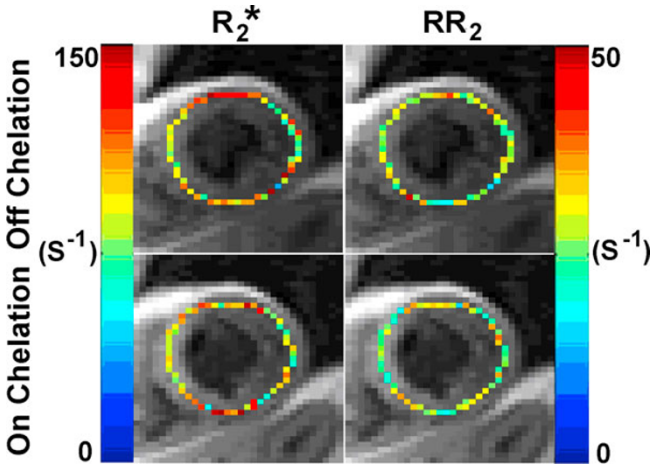

Figure 1
(Left column) R_2* and (right column) RR_2 maps: (top row) discontinuing chelation for one week; (bottom row) resuming chelation for one week.

Table 1: R2* and RR2 values of two groups after 1 week off and thereafter 1 week on iron chelation

Group	R2* (1/s)		Difference in R2* (1/s)	RR2 (1/s)		Difference in RR2 (1/s)
	Off	On	Off-On	Off	On	Off-On
1	62.3 ± 27.6	61.1 ± 30.6	1.2 ± 7.8	24.5 ± 4.8	22.0 ± 5.3	2.5 ± 1.8
2	74.1 ± 39.0	71.9 ± 43.3	2.2 ± 9.9	22.1 ± 5.4	20.0 ± 5.6	2.0 ± 2.2

standard R_2* mapping pulse sequence was also performed.

For data analysis, the septum was segmented manually. R_2* was calculated by non-linear least square fitting of the mono-exponential relaxation curve. The RR_2 was calculated by non-linear least square fitting of the three sets of non-monoexponential relaxation curves with different ESPs [6].

Results

Figure 1 shows R_2* and RR_2 maps of a patient after one week off and thereafter one week on iron chelation. In both groups (Table 1), the mean RR_2 was significantly decreased on compared to off iron-chelating therapy (group1: 22.0 ± 5.3 s^{-1} vs. 24.5 ± 4.9 s^{-1}; $p < 0.01$; group 2: 20.0 ± 5.6 s^{-1} vs. 22.1 ± 5.4 s^{-1}; $p < 0.01$), whereas R_2* was not different between the two states (group1: 61.1 ± 30.6 s^{-1} vs. 62.3 ± 27.6 s^{-1}; group 2: 71.9 ± 43.3 s^{-1} vs. 74.1 ± 39.0 s^{-1}).

Conclusion

This study demonstrates that a decrease in myocardial ferritin iron can be detected after as little as one week of iron-chelating therapy. Measurement of RR_2 may provide a new means of rapidly monitoring the effectiveness of iron-chelating therapy.

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