

POSTER PRESENTATION

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Are cardiac $R2^*$ values dependent on the image analysis approach employed?

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Background

CMR $R2^*$ is the gold standard for monitoring cardiac iron overload in patients with hemoglobinopathies. The $R2^*$ value is obtained by fitting the signal at different echo times (TEs) to an appropriate decay model. Patients with heavy cardiac iron burden ($R2^* > 100$ Hz) exhibit rapid signal, leading to a plateau in the later images. Two approaches have been used to address this. The first one (truncation model) consists in discarding the late “plateau” points and fitting the remaining ones with a single exponential model. The second approach is to fit the signal to an exponential decay plus a constant offset (Exp-C).

We aimed to determine whether systematic differences were present between $R2^*$ values obtained with these two approaches.

Methods

Single-center cohorts were used to compare black blood and bright sequences separately and a multi-center cohort of mixed bright and black blood studies was used to compare robustness and generalizability of the comparison. The $R2^*$ value within a region of interest (ROI) drawn in mid-ventricular septum was assessed using each of the two methods in turn. Truncated exponential estimates were calculated with CMRTools that uses a region-based approach ($R2^*$ CMRTools). Exp-C estimates were calculated using a rapid pseudo-pixelwise (PPW) implementation written in MATLAB. The mean and the median ($R2^*$ PPW-mean and $R2^*$ PPW-median) from the $R2^*$ distribution were obtained. To distinguish whether differences in measured $R2^*$ values resulted from the

underlying fitting model or from the use of a PPW rather than a region-based approach, we performed Exp-C fits to a single ROI ($R2^*$ PPW-ROI_based).

Results

Table 1 shows the results for the two methods. No differences could be distinguished based upon whether a white or black blood sequence was examined. The two fitting algorithms gave similar $R2^*$ values, with R-squared values exceeding 0.997 and CoV of 3-4%. Results using the PPW method yielded a small systematic bias that became apparent in patients with severe iron deposition. This disparity disappeared when Exp+C fitting was used on a single ROI suggesting that the use of pixelwise mapping was responsible for 3% bias. In the multicenter cohort the strong agreement between $R2^*$ values obtained with the two approaches was reconfirmed.

Conclusions

Cardiac $R2^*$ values are independent of the signal model used for its calculation over clinically relevant ranges; pixelwise fitting generate insignificantly greater $R2^*$ estimates at high iron concentrations. The overall variability between the techniques is exceeding small allowing clinicians to compare results with confidence.

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Table 1

	Paired t-test		Regression Analysis				Bland Altman		CoV (%)
	Mean Values (Hz)	P	Slope	P for Slope ≠1	Intercept (Hz)	R-squared	Mean diff (Hz)	Limits (Hz)	
a) First single-center cohort: black blood images (N=42)									
R2* Iron-mean VS R2* CMRTTools	48.5±54.7 vs 48.2 ±53.1	0.945	1.031 ±0.005	<0.0001	1.176±0.379	0.999	0.3	4.4 to 5.1	3.53
R2* Iron-median VS R2* CMRTTools	48.9±55.0 vs 48.2 ±53.1	0.258	1.036 ±0.007	<0.0001	-1.007±0.473	0.998	0.7	- 5.0 to 6.5	4.37
R2* Iron-ROI_based VS R2* CMRTTools	48.9±52.7 vs 48.2 ±53.1	0.063	0.993 ±0.007	0.336	1.058± 0.512	0.998	0.7	-4.1 to 5.5	3.66
b) Second single-center cohort: bright blood images (N=70)									
R2* Iron-mean VS R2* CMRTTools	47.6±37.9 vs 47.2 ±36.9	0.088	1.025 ±0.005	<0.0001	-0.741±0.300	0.998	0.4	-3.1 to 3.9	2.70
R2* Iron-median VS R2* CMRTTools	47.7±38.2 vs 47.2 ±36.9	0.085	1.035 ±0.006	<0.0001	-1.190±0.373	0.998	0.4	-4.0 to 4.9	3.45
R2* Iron-ROI_based VS R2* CMRTTools	47.5±37.4 vs 47.2 ±36.9	0.050	1.013 ±0.004	0.002	-0.245±0.247	0.999	0.4	-2.3 to 3.0	2.06
c) Multi-center cohort (N=62)									
R2* Iron-mean VS R2* CMRTTools	43.5±22.6 vs 43.8 ±22.7	0.250	0.989 ±0.008	0.148	0.108±0.372	0.997	-0.4	-3.0 to 2.3	2.25
R2* Iron-median VS R2* CMRTTools	43.7±22.4 vs 43.8 ±22.7	0.989	0.982 ±0.007	0.015	0.705±0.359	0.997	-0.1	-2.7 to 2.6	2.25
R2* Iron-ROI_based VS R2* CMRTTools	44.0±22.5 vs 43.8 ±22.7	0.207	0.989 ±0.007	0.131	0.681±0.352	0.997	0.2	-2.3 to 2.7	2.07

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