Analysis of Timing Dependence on Cardiac T1 Measurements in Amyloid Patients

D. W. Rettmann[1], D. W. Stanley[1], S. N. Gupta[2], and J. F. Glockner[3]

[1]GE Healthcare, Rochester, MN, United States, [2]GE Healthcare, Bethesda, MD, United States, [3]Department of Radiology, Mayo Clinic, Rochester, MN, United States

Introduction

Cardiac involvement in systemic amyloidosis has important implications for treatment and prognosis. Diagnosis of cardiac amyloid with MRI can be problematic, and is most commonly characterized by diffuse patchy enhancement and difficulty achieving normal myocardial nulling on myocardial delayed enhancement (MDE) sequences.

Previous work using an ECG-gated multiphase inversion recovery sequence (CINE-IR) has shown that post injection of Gd-DTPA the T_1 of blood is significantly higher and the T1 of myocardium lower in amyloid patients verses controls (1). This work also showed good sensitivity and specificity in identifying cardiac amyloid by using the difference in calculated T1's of the subendocardial tissue and the blood with CINE-IR data collected at 4 minutes in conjunction with a finding of global subendiocardial late gadolinium enhancement.

The intent of this work is to evaluate the dependence of the acquisition time of the CINE-IR data with respect to gadolinium injection on the difference of the T1 of blood and myocardium using a segmented gradient echo multiphase inversion recovery sequence (2).

Methods

Nineteen patients diagnosed with amyloid where scanned on a 1.5T Signa Excite MRI scanner (GE Healthcare, Waukesha, WI) under an institutional review board approved protocol, using an ECG-gated fast gradient echo CINE-IR sequence (TR/TE 6.0/2.8 ms, FA 12°, BW ±31 kHz, FOV 36 cm, matrix 224 x 160, 0.5 NEX, VPS 8, thickness 8 mm). A single mid-ventricular short axis CINE-IR slice was acquired at 3, 5 and 10 minutes after injecting 0.2 mmol/kg Gd-DTPA intravenously. Resulting data was processed using a custom T_1 mapping analysis package (Cinetool, GE Healthcare). Regions of interest were drawn in the left ventricular (LV) septum and the blood pool such that the same anatomical regions were being analyzed throughout the cardiac cycle and between the three different acquisitions. Signal-intensity vs TI time curves were generated, an unwrapped signal was created, and the T1 value was estimated by a non-linear least-squares curve fitting using the following inversion-recovery imaging equation: $S(TI) = A + B \exp(-TI/T1)$, where A, B, and T1 are the free parameters in the curve-fitting. Means and standard deviations of the calculated T1 measurements were computed and a one-way ANOVA analysis was performed to determine if a statistical difference ($P < 0.05$) was present between the three time points.

Results

The mean±standard deviation of the calculated T1 for the blood pool, myocardium, and the differences between the two are summarized in Table 1. As expected the T1 of the blood increased over time due to gadolinium washout with a trend towards significance ($P = 0.06$). Similarly, there was a significant increase in measured T1 of the myocardium over time ($P = 0.02$). Most importantly, a statistically significant difference was not found for the difference of the blood and myocardial T1's ($P= 0.76$) over time. A plot showing the T1 differences for all patients at the three time points is shown in Figure 1.

	3 minutes	5 minutes	10 minutes
T1 Blood	246±86 ms	292±118ms	354±126 ms
T1 Myocardium	270±117 ms	289±111ms	384±211 ms
T1 Blood – T1 myocardium	-23±119 ms	3±137 ms	-29±179 ms

Table 1: The mean±standard deviation of the calculated T1 for the blood, myocardium and the difference between the two.

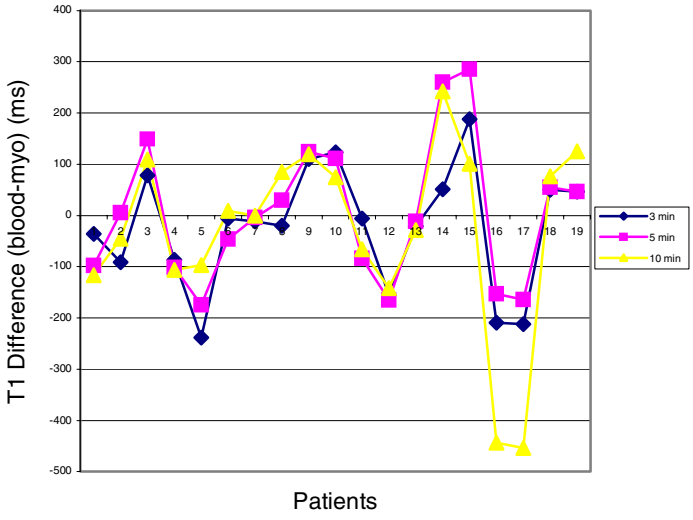

Figure 1: Plot of the difference between the T1 of blood and myocardium in 19 patients shows no trend in the difference between the results at 3, 5 and 10 minutes post injection of gadolinium contrast agent.

Conclusion

The results of this preliminary study indicate that the difference in the T1 of the blood and myocardium does not change significantly between three and ten minutes after Gd-DTPA injection. This suggests that the design of a cardiac MR protocol for diagnosing amyloid may be more flexible when determining the order of the MR sequences after Gd-DTPA injection. In future work, this analysis will be extended to a larger patient population.

References

[1] Macerira, et. al. Circulation. 2005 Jan 18;111(2):186-93

[2] Ho, et al., Proc ISMRM 2005:1675