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Characterization of myocardial T_1 and partition coefficient as a function of time after gadolinium delivery in healthy subjects

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Background

Diffuse myocardial fibrosis is associated with myocardial infarction [1], heart failure [2] and dilated cardiomyopathy [3]. Conventional T_1-weighted late gadolinium enhancement (LGE) imaging highlights focal scaring in contrast to remote reference tissue, but it cannot detect global changes in T_1 associated with diffuse fibrosis. Quantitative T_1 imaging permits assessment of diffuse fibrosis by eliminating the use of reference tissue, but the dependence of the derived partition coefficient (lambda) on the time post-contrast injection (t_{post}) is not well established.

Purpose

Determine blood and myocardial T_1 values as a function of t_{post} and the resulting dependence of the blood-tissue partition coefficient.

Methods

Nine healthy subjects (22.0±5.5 yrs, 6 male) were imaged using a Siemens Avanto 1.5T MRI. T_1 mapping was performed on a mid-ventricular short-axis slice using a custom saturation recovery single-shot TrueFISP sequence at baseline and one-minute intervals for 15 minutes following a bolus injection of gadopentetate dimeglumine (0.1 mmol/kg). At each time point, one "no-saturation" image and nine images with varying saturation recovery times spanning the cardiac cycle were acquired during a single breath-hold.

The myocardium was divided into 18 segments and mean values were fitted to a 3 parameter saturation recovery curve to determine T_1 values for each segment at every time point. Blood T_1 values were computed using a region of interest within the left ventricular cavity. Lambda was computed using {lambda=[R_1(myocardium$_{post}$) - R_1(myocardium$_{pre}$)]/[R_1(blood$_{post}$) - R_1(blood$_{pre}$)]}, where $R_1=1/T_1$.

Results

Figure 1 shows myocardial T_1, blood T_1, and lambda values averaged over all segments and subjects as a function of t_{post}. Average within-subject standard deviations of T_1 and lambda for t_{post} from 3-15 min were 34.1 ms and 0.046 respectively. Linear regression for lambda and t_{post} (3-15 min) shows an increase in lambda of 0.001 min^{-1} (R^2=0.75). Quantitative T_1 imaging is likely to be added to a clinical protocol following LGE imaging (t_{post} 10-15 min), where T_1 values increase by 5.9±1.6% and lambda increase by 1.1±2.7%.

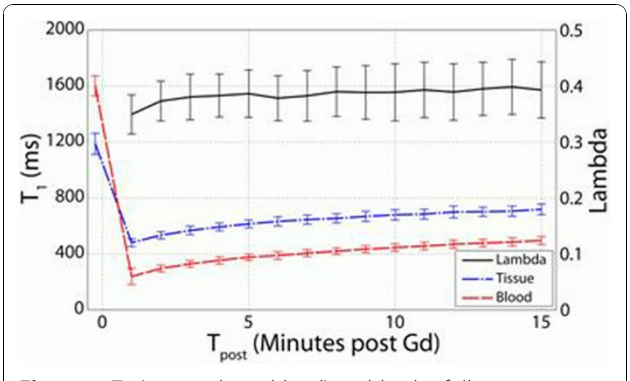

Figure 1 T_1 (myocardium, blood) and lamba following contrast injection.

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Conclusion

Saturation recovery SSFP T_1 mapping can be performed in a single breath-hold with derived blood-tissue partition coefficient (lambda) values in good agreement with previous measurements[3]. In the post-LGE window of 10-15 min after contrast bolus, derived lambda values show less time dependence than myocardial T_1.

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