Myocardial Infarction Alters Dynamic Contrast Enhancement (DCE) Curve Shapes as well as Peak Enhancement: A Study using Plots of Myocardial vs. Blood Longitudinal Relaxation Rates

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Purpose: To investigate differences in curve shapes between viable and infarcted myocardium using plots of myocardial vs. blood longitudinal relaxation rates and resulting effects on myocardial partition coefficient calculations.

Introduction: In this study, we hypothesized that myocardial fibrosis alters not only tissue Gd-contrast agent concentrations, but also Gd-contrast agent dynamics. Regional elevations in myocardial MR imaging Gd-contrast agent concentrations have been definitively shown to be associated with irreversible injury defined histologically. The current challenge is that conventional late gadolinium-enhanced (LGE) techniques cannot reliably be used to detect global or diffuse fibrosis due to the lack of a normal myocardial reference region to detect regional gadolinium contrast agent elevations. Several quantitative measures have been explored and primarily rely on post-contrast myocardial T1 measurements. Post-contrast T1 measurements can be used by themselves or in conjunction with a pre-contrast myocardial T1 measurement and hematocrit to provide a quantitative variable related to the contrast agent concentration and hence degree of myocardial fibrosis. An accurate measure could be used for disease detection and characterization, individual patient risk stratification and pharmacological therapy evaluation.

Materials and Methods: Twenty patients with chronic myocardial infarction underwent MR imaging at 1.5T with blood and myocardial T1 measurements before and after contrast administration for forty minutes. Myocardial partition coefficients for viable and infarcted myocardium were calculated using linear regression of myocardial vs. blood R1 plots with methods varying temporal sampling (number of samples, first post-contrast measurement, sampling interval) and the inclusion of pre-contrast measurements. Partition coefficients and model coefficients of determination were compared with paired statistical tests.

Results: The partition coefficient did not vary significantly between methods ($p=0.325$) for viable myocardium but did differ for infarcted myocardium ($p<0.001$). This was accompanied by better model fits (R^2) for viable when compared to infarcted myocardium. There was a significant difference between the partition coefficients for viable and infarcted myocardium for all methods with the exception of methods that included measurements from the first 10 minutes after contrast agent administration.

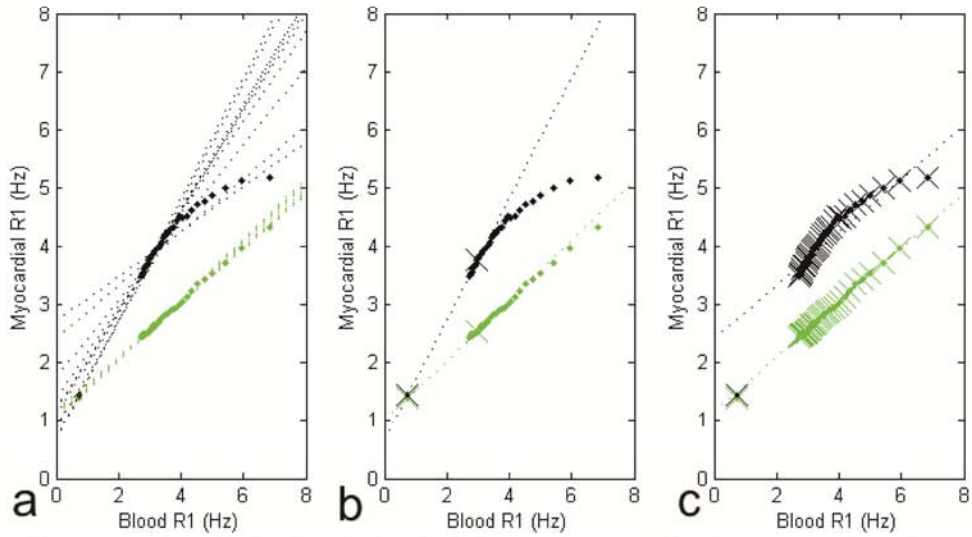

Figure 1. (a) Linear regression with the 10 studied methods from study means. Note the greater variance between methods of the slopes for myocardial infarction when compared to viable myocardium. (b) Standard two-point partition coefficient calculation using pre-contrast and 30 minutes post contrast acquisitions. Note the increased slope (partition coefficient) for myocardial infarction. (c) Linear regression using pre-contrast and 40 minutes post-contrast. Note the better linearity of viable myocardium and better fit of pre-contrast measurement and similar slopes. Black=Myocardial Infarction; Green= Viable Myocardium. Xs mark data points used for linear regression.

Conclusions: Myocardial fibrosis alters Gd-contrast agent dynamics. Myocardial partition coefficients calculated from a multipoint slope calculation will vary in healed myocardial infarction based on the selection of samples. This includes the use of pre-contrast measurements and samples early after contrast agent administration. Partition coefficient calculations are insensitive to data sampling effects in viable myocardium.