Comparison of DCE-MRI and Dual Echo DSC-MRI Derived Measures of K^{trans} and v_e

C. C. Quarles[1], J. C. Gore[1], and T. E. Yankeelov[1]
[1]Radiology and Radiological Sciences, Vanderbilt University, Nashville, TN, United States

Introduction: DSC-MRI data from tumors may be confounded by the extravasation of contrast agent (CA) into the extravascular extracellular space (EES), which results in simultaneous changes in the EES T_1 and T_2*. It is well known that dual-echo acquisitions can eliminate the T_1 leakage effects, but we recently demonstrated that such data, when combined with a pre-contrast T_1 map, can also be used to quantify the DCE-MRI parameters, K^{trans} and v_e (1). To further verify this approach we compared DSC-MRI and DCE-MRI derived K^{trans} and v_e values in two brain tumor models with dissimilar perfusion characteristics and contrast agent dynamics.

Methods: Using a 4.7T MR system, DCE-MRI and dual echo DSC-MRI data were sequentially acquired in C6 (n = 12) and 9L (n = 10) brain tumor bearing rats. Gd-DTPA, was injected through a jugular vein and four hours elapsed between each CA injection to allow for its clearance. Pre-contrast T_1 maps were acquired prior to each CA injection. The reference region approach was used to compute voxel-wise DSC-MRI and DCE-MRI based K^{trans} and v_e values (2). Maps were statistically compared using both region-of-interest (ROI) and individual level voxel-wise analysis.

Results: Despite the markedly different CA kinetics exhibited by C6 and 9L tumors, DSC-MRI and DCE-MRI R_1 time curves were very similar in shape and magnitude as illustrated in Figure 1. Table 1 summarizes the ROI intraclass correlation coefficient (ICC), Pearson's CC (r) and slope analysis. Similar correlation and slope values were found for the individual level analysis. All correlations were significant ($p < 0.05$) and no significant differences were found between the mean values of the K^{trans} and v_e parameters. Generally, the DSC-MRI parameters, which were computed from the second CA injection, were lower than those measured with DCE-MRI (as reflected in the slope values) but this was not unexpected as similar results have been reported in DCE-MRI repeatability studies (3).

Table 1	ICC	r	slope
ROI K^{trans} (All)	0.98	0.98	0.95
ROI v_e (All)	0.81	0.90	0.57
ROI K^{trans} (C6)	0.88	0.99	0.60
ROI v_e (C6)	0.80	0.91	0.54
ROI K^{trans} (9L)	0.97	0.97	0.88
ROI v_e (9L)	0.91	0.93	0.78

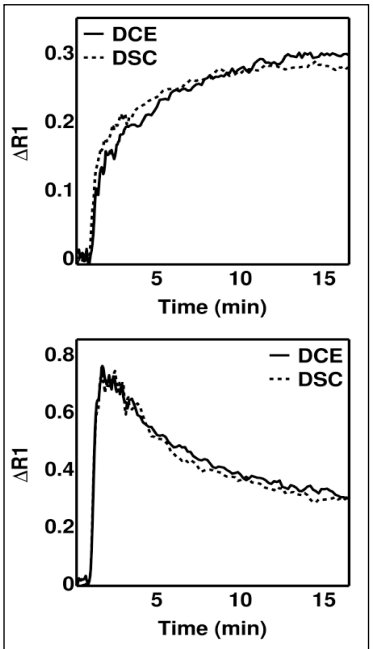

Figure 1: Example DSC and DCE ΔR1 time curves from C6 (A) and 9L (B) tumor tissue.

Discussion: We found a high degree of correlation between the DSC-MRI and DCE-MRI derived parameters within tumors and across two tumor types. In this case a high correlation indicates that the DSC-MRI approach is sensitive to the same physiological range of K^{trans} and v_e parameters as is measured with DCE-MRI. The mean tumor K^{trans} and v_e parameters for each method were also in good agreement as no significant differences were found in either the C6 or 9L tumor models. This finding suggests that quantitative DSC-MRI measures of the K^{trans} and v_e parameters should be comparable to those found using conventional DCE-MRI assuming the same kinetic model is applied to both datasets. Given the experimental and clinical success of DCE-MRI to assess tumor angiogenesis, tumor grade and treatment response, the DSC-MRI approach proposed herein, could serve as an important tool in the assessment of the tumor vascular and hemodynamic status.

References: 1. Quarles CC, *et al*, ISMRM 2007, 2. Yankeelov TE, *et al*, MRI 2005, 3. Yankeelov TE, *et al*, JMRI 2006.
Acknowledgements: NCI K99/R00 CA127599, NCI P30 CA068485, NCI U24 CA126588, NIBIB 1K25 EB005936