A Comparison of Signal Intensity & DCE-MRI Based Methods for Assessing Enhancing Fraction

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Purpose In GBM, $EnF_{IAUC60>0}$ has been shown to correlates with DCE-MRI derived K^{trans} [1]. K^{trans} has previously identified as a prognosticator in GBM [2]. $EnF_{IAUC60>0}$ requires a dynamic acquisition and calculation of initial area under the contrast agent concentration curve (*IAUC*). This adds to the scan time and requires complex post processing analysis with conversion of signal intensity changes into contrast agent concentration levels. If a similar measurement of EnF could be obtained from routine clinical imaging which would not require an additional dynamic sequence and complex post processing analysis this would be highly desirable in translating the measurement of EnF into clinical pratice. The aims were to evaluate the feasibility of measuring EnF (EnF_{SI}) from routine pre and post-contrast T_1-weighted imaging and assess its relationship with K^{trans}.

Materials and Methods 30 GBM were imaged pre-operatively. Imaging included pre and post-contrast T_1-weighted images (TR 10 ms, TE 500 ms, slice thickness 4.0mm, 256x256) and a T_1-DCE-MRI protocol (3 pre-contrast spoiled fast field echo sequences with different flip angles (2°, 10°, 16°) for calculation of baseline T_1 maps (TR 3.5ms, TE 1.1ms, slice thickness 4.2mm, 128x128) and a dynamic, contrast enhanced acquisition series with identical acquisition parameters as the variable flip angle baseline T_1 measurement, consisting of 100 volumes with temporal spacing of approximately 3.4 seconds, with gadolinium-based contrast agent injected as a bolus of 3ml, at 15 mls^{-1}, at a dose of 0.1$mmolkg^{-1}$ of body weight after acquisition of the fifth image volume). Parametric maps of *IAUC* and K^{trans} were generated. Volumes of interest were drawn for whole tumour (VOI_{tumour}) and contralateral normal appearing white matter (VOI_{nawm}). $EnF_{IAUC60>0}$ was calculated by dividing number of voxels with *IAUC*>0mMol.s, by total number of voxels in VOI_{tumour}. The mean change in signal intensity + 2 standard deviations for VOI_{nawm} (meanΔSI_{nawm}+2SD) was calculated. EnF_{SI} was calculated by dividing number of voxels with signal intensity change greater than meanΔSI_{nawm}+2SD by total number of voxels in VOI_{tumour}. Agreement between measures was assessed with Bland/Altman plots. Spearman correlation analysis was performed to assess the relationships with K^{trans}.

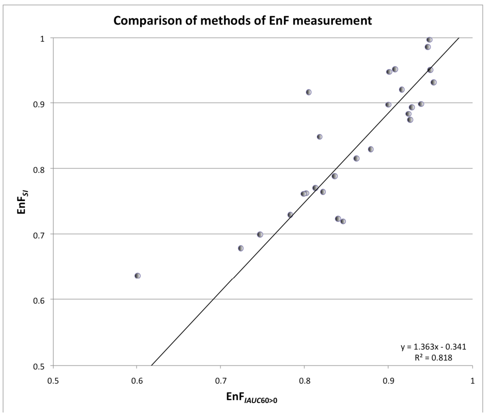

Figure 1 Scatterplot of $EnF_{IAUC60>0}$ versus EnF_{SI} for all patients. There is a significant correlation between the two parameters (ρ=0.870, p<0.0005 and R^2=0.818)

Results There was good correlation between the two measures (Figure 1). However, Bland Altman plots showed the measures were not directly interchangeable (Figure 2). The mean difference between $EnF_{IAUC60>0}$ and EnF_{SI} was 0.0378 (range -0.112 to 0.264, std. dev 0.07573). Low values of EnF (<0.70) demonstrated the greatest discrepancy. Both measures demonstrated significant correlations with K^{trans} ($EnF_{IAUC60>0}$: ρ=0.462, p<0.05 and EnF_{SI}: ρ=0.488, p<0.01).

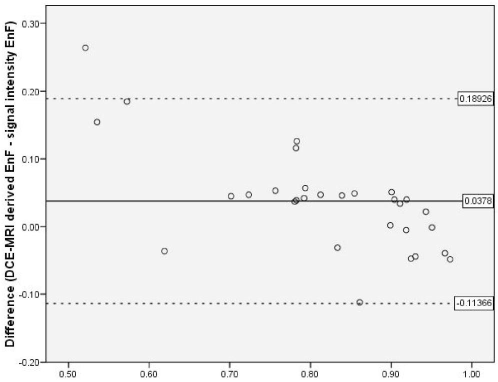

Figure 2. Bland Altman Plot of Average Enhancing Fraction determined by the two measures of EnF ($EnF_{IAUC60>0}$ and EnF_{SI}) versus the mean difference between the two measures ($EnF_{IAUC60>0}$ minus EnF_{SI}). Solid line = mean difference. Dashed line = standard deviation.

Conclusion $EnF_{IAUC60>0}$ and EnF_{SI} are not directly interchangeable measures but both correlate with K^{trans}. Further work is required to assess the prognostic utility of these measures.

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References

1. Mills S, Soh C, O'Connor JP, et al. Enhancing Fraction in Glioma and its relationship to the tumoural vascular microenvironment: A Dynamic Contrast Enhanced Magnetic Resonance Imaging Study. *AJNR Am J Neuroradiol* **2009**
2. Mills SJ, Patankar TA, Haroon HA, Baleriaux D, Swindell R, Jackson A. Do cerebral blood volume and contrast transfer coefficient predict prognosis in human glioma? *AJNR Am J Neuroradiol* **2006**;27:853-858