

T2*-correction in DCE-MRI from double echo acquisitions

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Introduction: Dynamic contrast enhanced (DCE) imaging is an established method for analysis of capillary permeability (K^{trans}) and plasma volume (Vp) in neoplasms (1). In order to obtain absolute estimates of K^{trans} and Vp, the tissue response must be deconvolved with the arterial input function (AIF). Accurate estimation of the AIF is critical for this analysis and depends on a known dose-response as well as absence of partial volume effects (PVE). In the present work we specifically address the influence of T2*-effects on the AIF and its influence on the estimation of K^{trans} and Vp.

Method and Materials: DCE images were acquired in five patients with a total of 18 examinations as part of a prospective therapy response study in patients diagnosed with glioblastoma. A double echo 3D saturation recovery (SR) sequence was used for the DCE analysis (TR/TD/TE1/TE2 = 3300 ms/80 ms/ 2.5 ms/5.6 ms) with a voxel size of 1.8 x 1.8 x 4 mm³. A dose of 0.1 mmol/kg of Gadovist was injected at a rate of 3 mL/sec. The double echo enabled quantification of T2* at each dynamic time-point by assuming a mono-exponential relationship between signal intensity (SI) and TE. Initially, the measured SI was converted to CA concentration from the known SI equation of the SR sequence by assuming T2*-effects to be negligible. Then, the effect of T2* was modeled from the measured dynamic T2*-response in the AIF. The obtained parameters K^{trans} , Vp and Ve (distribution volume) were then compared with and without correction for T2*-effects. Additionally post contrast 3D GRE images were acquired and regions of interest (ROI) were obtained by semi-automatic segmentation of the area of contrast enhancement. The permeability derived maps were then co-registered to the 3D GRE images and the respective parametric values were obtained from the defined ROIs. All imaging was performed at 3 T on a Philips Achieva system. The hemodynamic parameters obtained with and without correction were compared using a paired Wilcoxon signed rank test with a significance level of 0.01.

Results: There was a significant difference in both K^{trans} and Vp when analyzed with and without correction ($p < 0.002$ and $p < 0.0002$, respectively). In general both K^{trans} and Vp were over-estimated when T2*-effects were not corrected for. The effect was larger for Vp than for K^{trans} . There was no significant effect on Ve. The left panel in figure 1 shows a sample patient with the resulting K^{trans} and Vp maps obtained with and without T2*-correction. The corresponding AIFs are shown in the central panel. As expected the most dominant T2*-effect occurred during first pass, thereby causing a greater error in Vp which is mainly determined from the early time-points.

Conclusion: T2*-effects may have a significant effect on the AIF even when heavily T1-weighted DCE sequences with very short echo times are used. Since the T2*-effects are most dominant during first-pass, Vp will generally be more affected than K^{trans} , but both parameters were significantly over-estimated when T2*-effects were not corrected for.

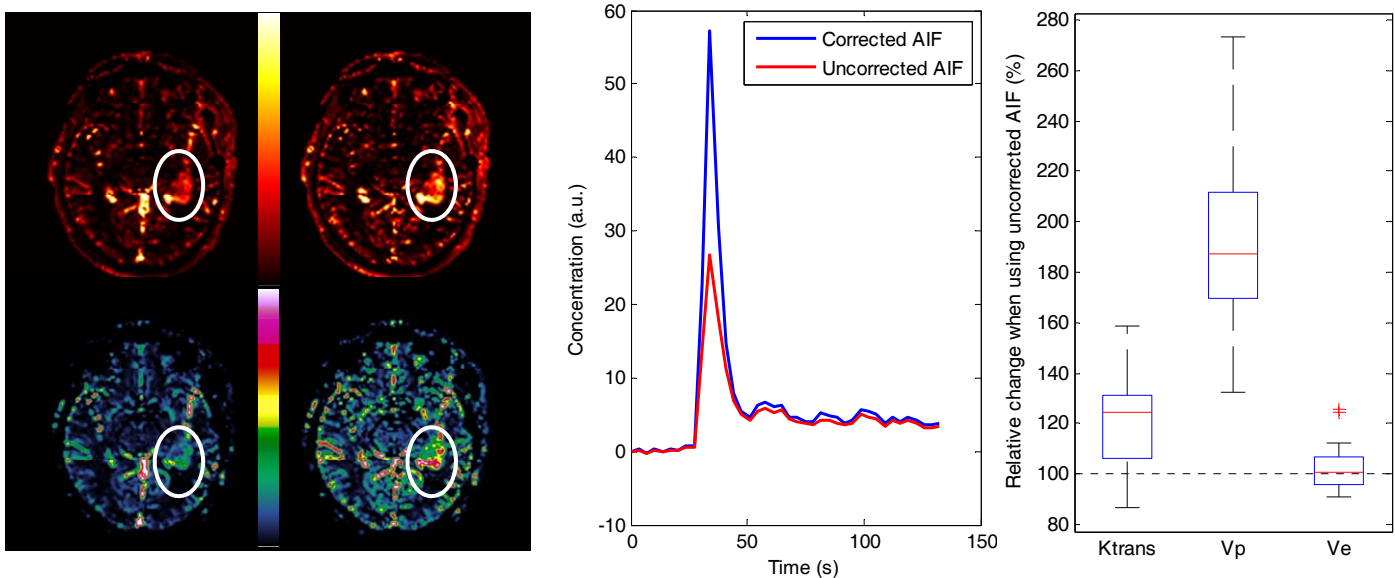


Figure 1: The left panel shows K^{trans} (top) and Vp (bottom) maps obtained with corrected (left) and uncorrected (right) AIF in a sample patient with white circles indicating the tumor area. The AIFs used are shown in the central panel. The box plot in the right panel shows the relative difference in parameter values in all examinations obtained using the uncorrected AIF compared to the same AIF with correction for T2*-effects.

[1] Tofts PS, et al. J Magn Reson Imaging;10:223-232 (1999)