In Vivo correlation between non-model-based parameters and model-based Ktrans in brain tumors

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Introduction:
Recently, dynamic contrast-enhanced MRI (DCE-MRI) has been more and more widely applied in cancer diagnosis and treatment follow-up because of its non-invasive and non-radiation. The most common estimated parameters in DCE-MRI are Ktrans and Ve. These parameters which come from pharmacokinetic models could be surrogates of the real physiology. However, the process of Ktrans estimation is not easy. The non-modeled parameter, such as IAUC, was often used owing to its advantages of avoiding some challenges associated with pharmacokinetic modeling. For overall application in the wide-ranged physiologic variations, a modified IAUCKtrans (mIAUCktrans) was proposed by simulation [1]. In this study, we aim to further investigate the application of mIAUCktrans in clinical and find the correlation between mIAUCktrans and Ktrans.

Materials and Methods:
Total 10 patients with brain tumors were participated in this study. Age ranged from 38 to 69 years (means=51±11.04 years) with 6 males and 4 females. DCE-MRI T1 weighted images in the axial plane were acquired by using a gradient-echo sequence with TR/TE/9°=5.8 msec/2.2 msec/30° by a 3 Tesla scanner. The bolus injection of 0.1 mmol/kg gadoninum agent was administered through the antebrachial vein by the power injector. Four parameters were utilized in this study: Ktrans, IAUCc, IAUCc, and mIAUCktrans. Ktrans were calculated according to the TK model [2]. IAUCc and IAUCc are the integral of signal time curve and the integral of concentration time curve during t1 (time point of contrast medium arrival) to t2 (the last time point within 60 seconds after contrast medium arrival), respectively. mIAUCktrans derived from the “curvature” of the vascular phase was calculated by the following equation:

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mIAUC_{ktrans} = \left\{ \frac{IAUC_{c1}}{IAUC_{REF20}} \right\}^{1.15} \times \left\{ \frac{IAUC_{10-30}}{IAUC_{REF20}} \right\}^{0.9} \times \frac{IAUC_{0-20}}{IAUC}_{REF20}
\]

The statistical correlations between Ktrans, IAUCc, IAUCc, and mIAUCktrans were processed with Matlab.

Results:
Figure 1 showed the maps of Ktrans, IAUCc, IAUCc, and mIAUCktrans from patient No.1 with anaplastic oligodendrogloma. As the map displayed, the maximum mIAUCktrans was found in the right frontal lesion, as the result from the map of Ktrans. The relationship between Ktrans and IAUCc, Ktrans and IAUCc, Ktrans and mIAUCktrans were displayed in Figure2. The correlation coefficients between these non-modeled parameters and Ktrans were 0.88, 0.92, and 0.95, respectively. With the p-value of 0.003, mIAUCktrans was significantly more correlated with Ktrans than the others.

Discussion and Conclusions:
The feasibility of mIAUCktrans applied in brain tumors was successfully demonstrated in this study. The advantages of the mIAUCktrans are easy-practiced in clinical usage and arterial input function (AIF) free. On the other hand, the AIF selection is one shortcoming for Ktrans calculation. Since the high correlation between Ktrans and mIAUCktrans was demonstrated in this study, it reveals that mIAUCktrans could be an alternative for physiological condition evaluation in DCE-MRI.

References: