# Comparison study of $T_2^*$ effects on DCE-MRI and $T_1$ effects on DSC-MRI between brain tumor and normal brain tissue

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## Introduction

Administration of contrast agent would induce changes of $T_1$ and $T_2^*$ value of tissue. $T_1$ weighted dynamic contrast enhanced (DCE) MRI and $T_2^*$ weighted dynamic susceptibility contrast (DSC) MRI could provide information of vascular permeability and perfusion characteristics, respectively. Commonly used contrast kinetic model for DCE-MRI assumes that there is only $T_1$ changes, while for DSC-MRI only $T_2^*$ changes are assumed. Dual echo pulse sequence has been proposed to simultaneously acquired $T_1$ - DCE and $T_2^*$ - DSC-MRI. [1-2] However, there is no systemic comparative investigation of $T_2^*$ effects on $T_1$ -DCE and $T_1$ effect on $T_2^*$ - DSC between normal and tumor tissues of brain. The goal of this work is to fill the gap.

## Materials and methods

A 2D dual echo FLASH pulse sequence was performed on a Siemens 3T MRI scanner with the first echo as $T_1$ DCE-MRI and the second echo as $T_2^*$ DSC-MRI. Gd-DTPA was used as contrast agent (0.2 mmol / kg,). Consent forms for subjects have been signed before experiments.

To eliminate $T_2^*$ effect on permeability analysis, firstly $T_1$ - DCE-MRI are compensated by excluding $T_2^*$ component. The rest of the equations for estimating permeability parameters such as $K^{trans}$ is the same as in literature [3]. To eliminate $T_1$ effects on perfusion analysis, firstly we calculate $T_2^*$ values of every time point taking advantage of dual echo data as described in literature [1]. Remaining equations for estimating perfusion parameters are the same as proposed in literature [4]

Permeability and perfusion (P&P) parameters of DCE-MRI and DSC-MRI data without correction are also calculated for later comparisons. Mean value of P&P parameters of selected ROIs are calculated to quantitatively evaluate the $T_2^*$ effects on permeability and $T_1$ effects on perfusion in tumor and normal tissue, respectively.

## Results

Fig.1A shows $T_1$-DCE signal intensity with and without $T_2^*$ correction in tumor and normal tissue, respectively. Fig.1B shows $T_2^*$-DSC concentration curve with and without $T_1$ correction in tumor and normal tissue. Fig.2 is the comparison of relative region cerebral volume (rCBV) mapping calculated from DSC-MR images with and without considering $T_1$ effect. Quantitative comparisons of $T_2^*$ effects on permeability and $T_1$ effects on perfusion between tumor and normal tissue has also been performed. Difference in percentage between relative rCBV of healthy tissue with and without $T_1$ correction is about 20%, but for tumor tissue it is about 153% (N=3).

## Discussion

As illustrated by Fig.1A 1) $T_2^*$ correction remove the signal loss due to $T_2^*$ shortening (pointed by arrows), and 2) $T_2^*$ shortening has much greater effects on $T_1$-DCE signal intensity of tumor than that of normal tissues. Fig.1B demonstrates 1) negative $T_2^*$-DSC concentration, which is non-physical, can be corrected with $T_1$ correction (pointed by arrow); 2) systemic error for $T_2^*$-DSC concentration curve due to reduced $T_1$ was much greater for tumor than that for normal tissue, and 3) there was a dramatic change in the pattern of tumor's concentration curve after $T_1$ correction. Quantitative comparison of permeability and perfusion parameters confirms that it is more crucial to correct $T_2^*$ effects on permeability and $T_1$ effects on perfusion in tumor tissue than normal tissue.

## Conclusion

$T_2^*$ effects on DCE-MRI and $T_1$ effects on DSC-MRI could lead to wrongly estimation of P&P parameters, and these effects are much greater in tumor regions than in normal brain tissue.

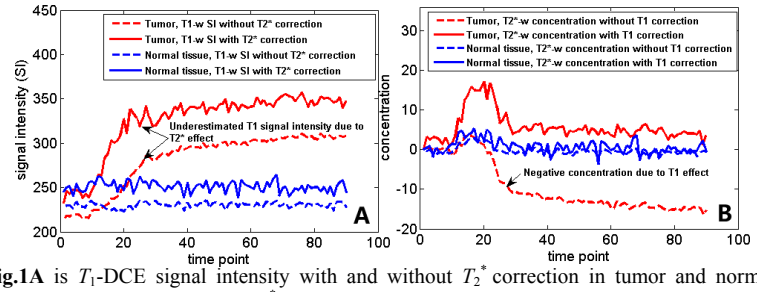


**Fig.1A** is $T_1$-DCE signal intensity with and without $T_2^*$ correction in tumor and normal tissue, respectively. **1B** shows $T_2^*$-DSC concentration curve with and without $T_1$ correction in tumor and normal tissue, respectively.

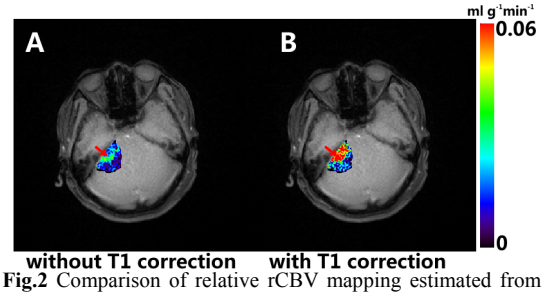


**Fig.2** Comparison of relative rCBV mapping estimated from DSC-MR images with and without $T_1$ correction

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