Correlation between Diffusion Tensor and Perfusion Imaging in segmented enhancing lesion with high grade glioma

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Introduction

Conventional MR imaging does not provide reliable information on tumor physiology such as microvascularity, angiogenesis or tumor cellularity, all of which are important in determing tumor grade. Advanced MR imaging techniques such as diffusion (DWI), perfusion (PWI) can provide important physiological information in brain tumors. Diffusion tensor metrics such as fractional anisotropy (FA) and apparent diffusion coefficient (ADC) in the tumor have been reported to be abnormal [1,2], and regional tumor blood volume (rTBV) has been reported to be higher in high grade gliomas compared to low grade gliomas [3,4]. The purpose of this study was to determine whether there was any correlations between FA, ADC and rTBV values within enhanced lesion on T1 contrast enhanced imaging (ceT1WI).

Materials and Methods

Thirty three patients (15M/18F, age 27-86) with pathologically proven brain high grade gliomas (4 anaplastic astrocytomas, 1 grade IV gliosarcoma, 28 glioblastoma multiforme) represented contrast enhancement on preoperative MR imaging were included in this study. All patients underwent MR examination before surgery on a 3T Siemens Tim Trio scanner with a 12-channel phase-array head coil. DTI was acquired with a 12-direction single shot, spin-echo echo planar sequence with parallel imaging using GRAPPA and acceleration factor of 2. Imaging parameters were as follows: TR/TE = 4900/83, FOV = 22x22 cm^2, matrix = 128x128, b values = 0 and 1000 s/mm^2, slice thickness 3mm, no intersection gap. FA and ADC maps were computed using DtiStudio, Version 3.0 (Johns Hopkins University, Baltimore, MD). Dynamic susceptibility contrast T2* weighted gradient echo planar perfusion weighted images (DSC-PWI) were acquired during the first pass of the standard dose (0.1 mmol/kg) of gadopentetate dimeglumine contrast agent. For DSC-PWI, 3mm thick axial sections were acquired through the tumor based on FLAIR images. Other parameters included FOV = 22x22cm^2, matrix size=128x128, in-plane resolution 1.72x1.72x3mm^3, and TR/TE = 2000/45ms, bandwidth= 1346Hz, flip angle 90°, EPI factor=128 and echo spacing=0.83ms. TBV maps were constructed using commercial workstation (Leonardo, Syngo software Siemens, Erlangen, Germany) by the same technician. The procedure used to generate TBV maps from the DSC-PWI data was based on standard algorithm[5]. CeT1WI, FLAIR, FA, ADC and TBV maps were converted to Analyze format by using MRIcro software[6]. Co-registration of all images was performed by using SPM99 software (Wellcome Trust Centre for Neuroimaging, London, UK) to trace the same area in each sequences. We set the definite threshold and extracted only enhancing lesion within the tumor by using MRIcro and measured ADC, FA and rTBV value in segmented lesion. Upon normalization of these values to the contra-lateral normal side, the data was compared across non-parametric Spearman's test to evaluate the correlation between these data.

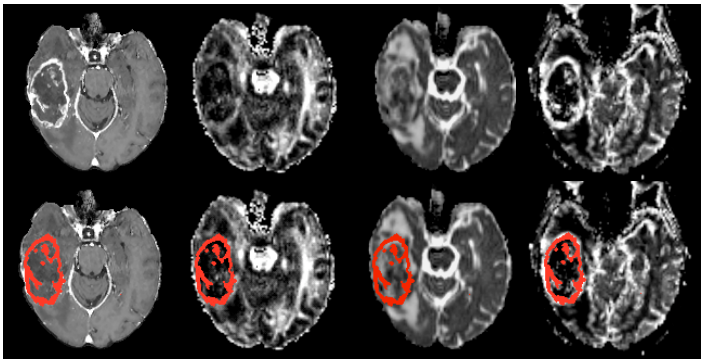

Fig.1 Co-registration images with T1 contrast-enhanced images. After co-registered images (T1 contrast-enhanced images, FA, ADC and rTBV; left to right). For a patient with GBM (top row) and overlaid ROI images (bottom row). By using this method, we can extract only enhancing lesion within tumor and measure each value in the same area, automatically.

Results

Representative images for patients with GBM (top row) and overlaid ROI image extracting only enhancing lesion within tumor (bottom row) are shown in Fig.1. Applying for both co-registration and segmentation, we could calculate each value in the same, definite (enhancing) lesion, automatically. Normalized FA (nFA), ADC (nADC) and rTBV (nTBV) values are shown in Table 1. There was a negative correlation between nTBV and nFA value ($p < 0.05$, Spearman's test).

Table 1: The correlation between normalized FA, ADC and rTBV values within enhancing lesion on MRI

Spearman's test	nTBV	nADC	nFA
nTBV	-	**0.2283**	**0.0470**
nADC		-	**0.1510**
nFA	*		-

*indicates statistically significant difference ($p< 0.05$)

Discussion

In this study, a semi-automatic method was applied along with the enhancing lesion in tumor, which might be a more reliable way to get the physiological information in brain tumors. Reduced FA and increased rTBV in enhancing area represented the damage of fiber and increased angiogenesis. This study may indicate the degree of these changes would be occurred almost simultaneously.

Reference

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